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COMMON PLANTS OF LONGLEAF PINE - BLUESTEM RANGE

Harold E. Grelen

Vinson L. Duvall

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COMMON PLANTS OF LONGLEAF PINE-BLUESTEM RANGE

Harold E. Grelen

Vinson L. Duvall

SOUTHERN FOREST EXPERIMENT STATION
Thomas C. Nelson, Director
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COMMON PLANTS OF LONGLEAF PINE-BLUESTEM RANGE

This publication describes many grasses, grasslike plants, forbs, and shrubs that inhabit longleaf pine-bluestem range. The species vary widely in importance; most produce forage palatable to cattle, some are noxious weeds, and others are valuable indicators of trends in range condition. All are abundant enough on certain sites, however, to require identification for accurate evaluation of grazing resources.

Each species is described, its value as food for cattle and wildlife assessed, and its geographic range indicated. Line drawings show salient taxonomic features of species mentioned briefly as well as of those described fully. To aid identification of plants without floral parts, descriptions stress vegetative characters that are peculiar to each species, but detailed botanical descriptions have also been provided. Scientific names are those used by the U. S. Forest Service Herbarium, Washington, D. C. Most common names are from Kelsey and Dayton (1942), but some have been taken from Little (1954) and Wolff (1954); all references consulted are listed in the bibliography.

THE TYPE

VEGETATION

In its virgin state, the longleaf pine-bluestem type was characterized by parklike stands of longleaf pine *(Pinus palustris* Mill.) and an understory dominated by bluestem grasses. Except for hardwood and mixed hardwood-pine forests bordering streams, the type reached virtually unbroken from west Florida to east Texas (see map).

Ecologists generally regard the longleaf pine-bluestem community as a fire subclimax—i. e., a successional arrestment induced by burning.

The longleaf pine-bluestem type.

Before settlement by white man, lightning-caused fires evidently swept broad areas at 2- to 3-year intervals. This largely excluded fire-intolerant species, allowing indefinite occupancy by longleaf pines, bluestem grasses, and associated species. Thus, the vegetation was in equilibrium with both the prevailing climate and the natural occurrence of fire.

The white man upset this balance, probably less by clear cutting the old-growth pines than by interrupting the burning sequence. After the timber was harvested, longleaf regenerated naturally on some areas; on others, however, man-caused fires were too frequent for successful reproduction. Where wildfire was excluded, loblolly pine *(Pinus taeda* L.), slash pine *(P. elliottii* Engelm.), and hardwoods from adjacent bottom lands often intruded. As forestry progressed, large tracts were planted or seeded to slash and loblolly.

Today, the forest canopy differs vastly from that encountered by early settlers. As composition of the overstory has shifted, so has that

of the understory. On open, cutover land, grass is far more abundant than it was under virgin forest, and species with low tolerance of shade often predominate. Conversely, herbaceous cover is sparse under dense loblolly, slash, and hardwood canopies, with species tolerant of heavy shade generally evident.

Irrespective of changes in overstory composition, bluestem grasses and their natural associates remain the most important forage species. They continue to dominate the understory on most sites. Even where bottom-land herbs have assumed dominance, bluestems may yield significant quantities of forage. Moreover, sound management of grazing resources favors the bluestem association.

GRAZING VALUES

Grazing capacity is greatest following clear cutting of pines. Herbage yields average about a ton (air-dry) per acre annually, and on choice sites exceed 3,000 pounds. On grazed range that is periodically burned, grasses comprise at least 90 percent of the vegetation; grasslike plants, forbs, and shrubs make up the rest.

On range grazed yearlong, cattle eat mostly grass. In Louisiana studies, the diet of breeding herds averaged 91 percent grass, 4 percent grasslike plants, 4 percent forbs, and 1 percent browse. Browsing was mainly in winter, when green grass was scarce.

When pines are regenerated, herbage remains essentially unchanged until the canopies close. Then yield diminishes, but thinning the trees usually restores moderate production. If pine stands are control-burned regularly and grazed moderately, proportions of grasses, grasslike plants, forbs, and shrubs are similar to those on cutover range, and most forests—either longleaf or slash pine—can provide forage in usable quantities throughout a timber rotation. Without grazing and fire, shrubs and scrub hardwoods drastically reduce grazing capacity, ultimately rendering the range unsuitable for cattle.

Although grass is often abundant, nutritive value varies considerably with stage of growth. New herbage contains adequate protein but is slightly deficient in phosphorus; old growth invariably lacks both. These imbalances, though serious, can readily be remedied by supplemental feeding. Thus, with sound management of forage and cattle, most longleaf pine-bluestem ranges can produce beef profitably.

WILDLIFE HABITAT

Longleaf pine-bluestem range is often excellent habitat for bobwhite quail. Wide use of fire in managing timber and forage promotes native legumes whose seeds are preferred by quail. On most sites, moreover, fire-tolerant shrubs are reliable producers of fruits that sustain quail when better foods are scarce.

Where cattle concentrate—on roadsides, firelanes, and feeding grounds—forbs often abound; some produce seeds preferred by mourning doves. Turkey and whitetail deer are found mainly in stream bottoms but depend on adjacent uplands for part of their food supply.

GRASSES

The native grasses of the longleaf pine-bluestem type vary widely in size, habit, environmental adaptability, and usefulness. Except for the woody bamboos, all species are annual or perennial herbs. Height varies from a few inches to 25 feet. Bunch grasses predominate, but prostrate forms that creep by rhizomes or stolons are common. Despite these variations, many vegetative characters are relatively constant for all grasses. Stems are typically hollow, though occasionally solid, with prominent joints or nodes. Leaves, arising alternately from the nodes in two ranks, are long and narrow, with margins and veins approximately parallel. The part of the leaf, which clasps the stem, is the sheath; it joins the blade, or upper part, at the collar. Although these features are usually enough to distinguish grasses from other plants, it is sometimes difficult to differentiate them from the closely related sedge and rush families, Cyperaceae and Juncaceae.

The range herbarium for the longleaf pine-bluestem type, maintained by the U. S. Forest Service at Alexandria, La., contains almost 200 grass species, with the collection still incomplete. Cattle graze almost all to some extent, but bluestems and panicums are usually the main sources of forage.

BLUESTEMS

Andropogon spp.

The bluestems, known also as "beardgrasses" or "sagegrasses," are the most valuable native forage grasses in the longleaf pine-bluestem type. They usually furnish more than half the forage for range cattle.

Southern bluestems are mainly bunchgrasses. Heights range from about 1 foot in fineleaf bluestem to more than 6 feet in big bluestem. Pinehill bluestem and slender bluestem, individually or in various combinations, are the main species on most longleaf pine-bluestem sites, but other bluestems are locally important. On soils too wet for upland species, for example, bushy bluestem often forms extensive stands.

Most species do not flower until late summer or fall; hence, identification during much of the year must be from vegetative characters. Culms are solid, while those of most range grasses are hollow. Tufts generally spread by tillering, but a few species, e. g., pinehill bluestem and big bluestem, are rhizomatous.

Inflorescences consist of several to many hairy racemes, these often protruding from a spathelike sheath at maturity. Fertile spikelets usually terminate in a twisted or bent awn. Old seedstalks, which commonly persist well into the growing season, may aid identification.

Key to bluestem grasses

1 RACEMES SOLITARY ON THE END OF EACH PEDUNCLE

2 Culms very slender, sprawling, blades 1 mm. or less wide

A. tener, slender bluestem→

2 Culms more robust, erect; blades more than 1 mm. (3-6 mm.) wide

3 Pedicellate spikelet as long as or longer than the pedicel and almost as large as the sessile spikelet; sheaths usually hairy

A. divergens, pinehill bluestem→

3 Pedicellate spikelet shorter than the pedicel and considerably reduced; sheaths usually glabrous

A. scoparius, little bluestem→

1 RACEMES 2 TO SEVERAL ON THE END OF EACH PEDUNCLE

4 Blades no wider than 2 mm., generally glabrous, but sometimes sparsely pilose along the margin near the ligule

A. subtenuis, fineleaf bluestem→

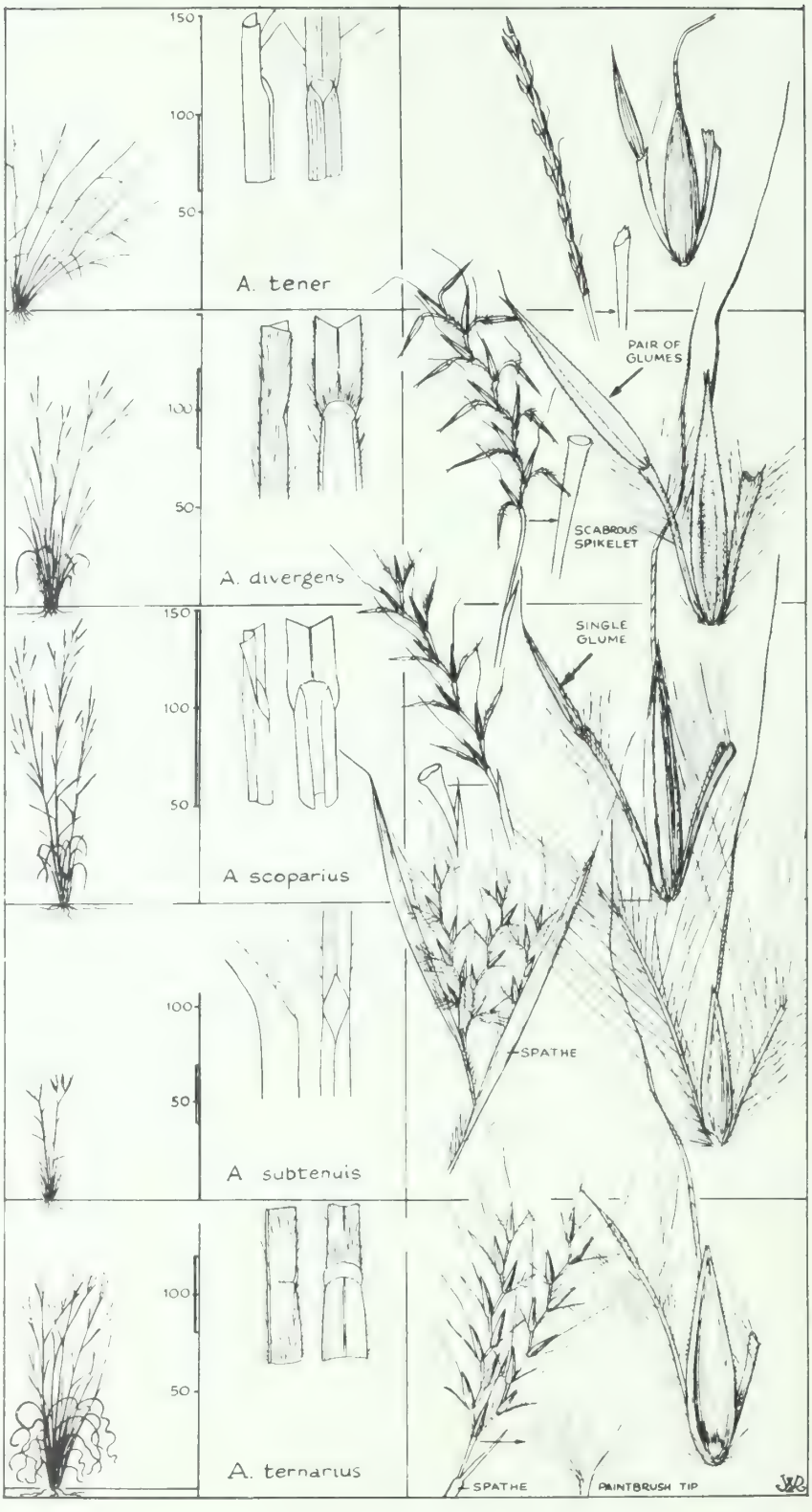
4 Blades 2-10 mm. wide (a form of *A. elliottii* may have blades less than 2 mm. wide); lower sheath and blades densely pilose especially near ligule

5 Peduncles 5-15 cm. long (*A. elliottii,* primary inflorescence)

6 Racemes in pairs, 3-6 cm. long, feathery, silver to cream in color

7 Spathes slender and inconspicuous

A. ternarius, paintbrush bluestem→



7 Spathes dilated, conspicuous, with very long, slender tips

A. elliottii, Elliott bluestem→
(See also 9 below)

6 Racemes 2-6, 5-12 cm. long, ciliate, yellowish to purplish in color; plants robust, culms 1-2 m. (3-7 ft.) tall

A. gerardii, big bluestem→

5 Peduncles less than 5 cm. long

8 Inflorescence large, the profuse pairs of racemes forming a dense mass; spathes narrow, rarely more than 2 mm. wide, inconspicuous; the ultimate branches dense and hairy below the spathes

A. glomeratus, bushy bluestem→

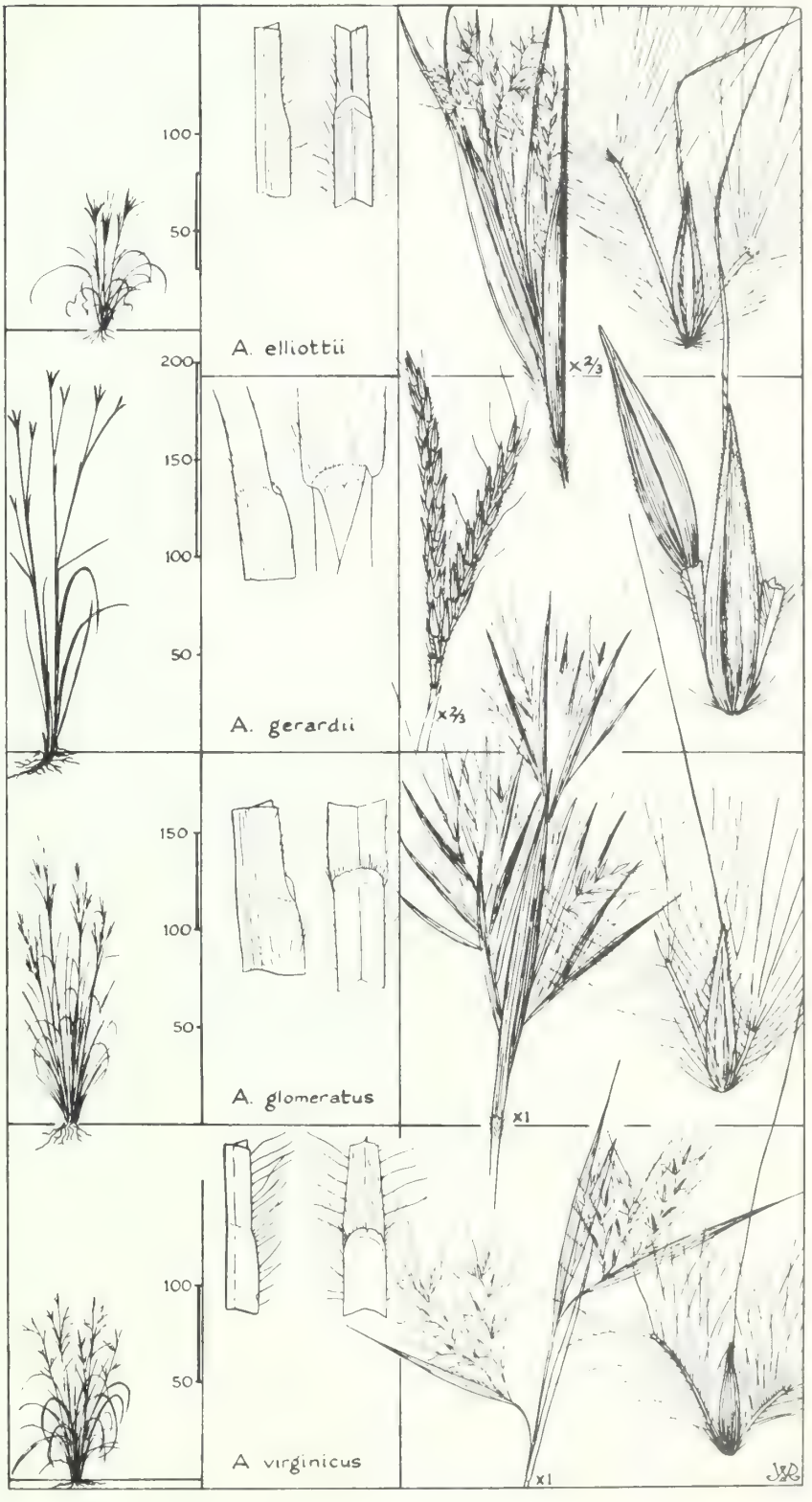
8 Inflorescence not as above

9 Spathes strongly inflated, the longest 10-25 cm., crowded and overlapping, the ultimate branches densely villous below the spathes

A. elliottii, Elliott bluestem
(See 7 above)

9 Spathes only slightly inflated, averaging 3-6 cm. long, not overlapping, but spaced at intervals along the culm and many branches; ultimate branches glabrous or with only a few hairs below the spathes

A. virginicus, broomsedge bluestem→



BIG BLUESTEM

Andropogon gerardii Vitm.

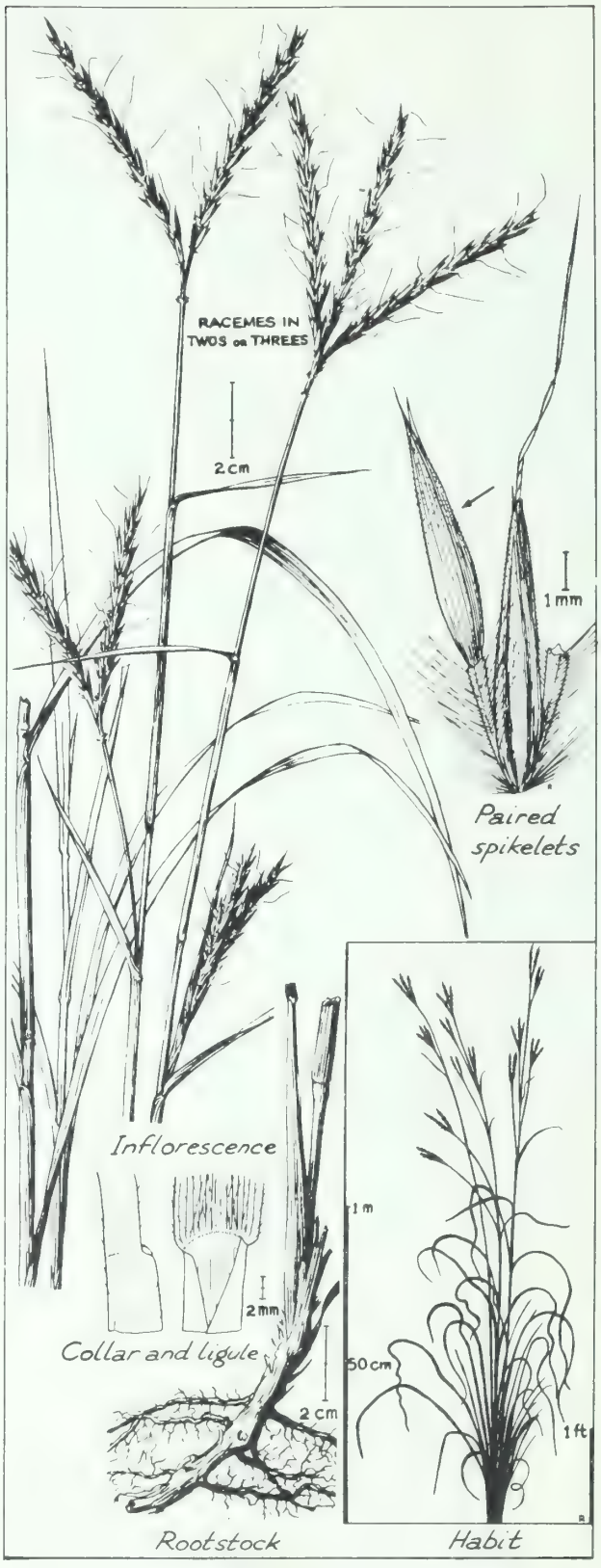
Big bluestem is the largest native bluestem in the United States, often reaching 6 feet. Although plants spread by short rhizomes, bases are often densely tufted, as in the true bunchgrasses. Leaves are mostly basal, with broad blades. Basal shoots are usually flattened. Leaves vary from very sparsely to densely hairy. Thick, purplish racemes are 2 to 4 inches long and generally in twos or threes; they diverge toward the tips in a "bird-foot" pattern that distinguishes big bluestem from all other southern grasses. Identification may be difficult during much of the growing season, however, for flowers rarely appear before late summer. Because palatability is high, cattle often graze the plants closely, preventing seedstalk development.

Without seed heads, big bluestem closely resembles Florida paspalum, but is usually distinguishable by vegetative characters. In big bluestem, leaf blades narrow slightly near the collar, widening gradually toward the midsection; blade width in Florida paspalum is relatively constant throughout the lower one-third to one-half. The inner surface of the big bluestem sheath is brownish to bronze, corresponding in color to the ligule, while that of Florida paspalum is green.

Because of its high yield and palatability, big bluestem is one of the best native forage grasses in the Prairie States. In the South, however, it is generally too scarce on most sites to contribute much forage. Because it is usually overgrazed when range stocking is based on the proper use of other bluestems, its presence on grazed range indicates lighter-than-average use.

Range: All of United States east of Idaho and Nevada.

Perennial. Culms stout, solid, 1-2 m. tall, sparingly branched toward the summit; **sheaths** glabrous or villous, wider than the blade, green or purplish, sometimes glaucous; **ligule** membranous, 1-4 mm. long, with or without a fringed margin; **blades** flat, elongate, 20-60 cm. long, 4-12 mm. wide, with scabrous margins and pale midveins that are wide and prominent near the ligules, tuft of hairs up to 1 cm. long behind ligule or only short scattered hairs; **racemes** mainly in twos and threes, to six or more on long-exserted terminal peduncles, 5-12 cm. long, green yellowish or purplish, often glaucous; **sessile spikelet** perfect, 7-10 mm. long, usually scabrous, the long awn tightly twisted and bent, 1-2 cm. long; **pedicellate spikelet** not reduced, staminate, awnless.



Big bluestem

BROOMSEDGE BLUESTEM

Andropogon virginicus L.

Broomsedge bluestem is perhaps the most common grass in the South. From windblown seeds it invades old fields, roadsides, and overgrazed ranges. It grows as a coarse, practically hairless bunchgrass about 3 feet tall. The basal leaf sheaths of lateral shoots are strongly flattened. Typically, basal sheaths are yellow; the rest of the plant is greenish yellow. However, a glaucous form, conspicuously blue gray to blue green, is common on poorly drained sites in central and southwest Louisiana.

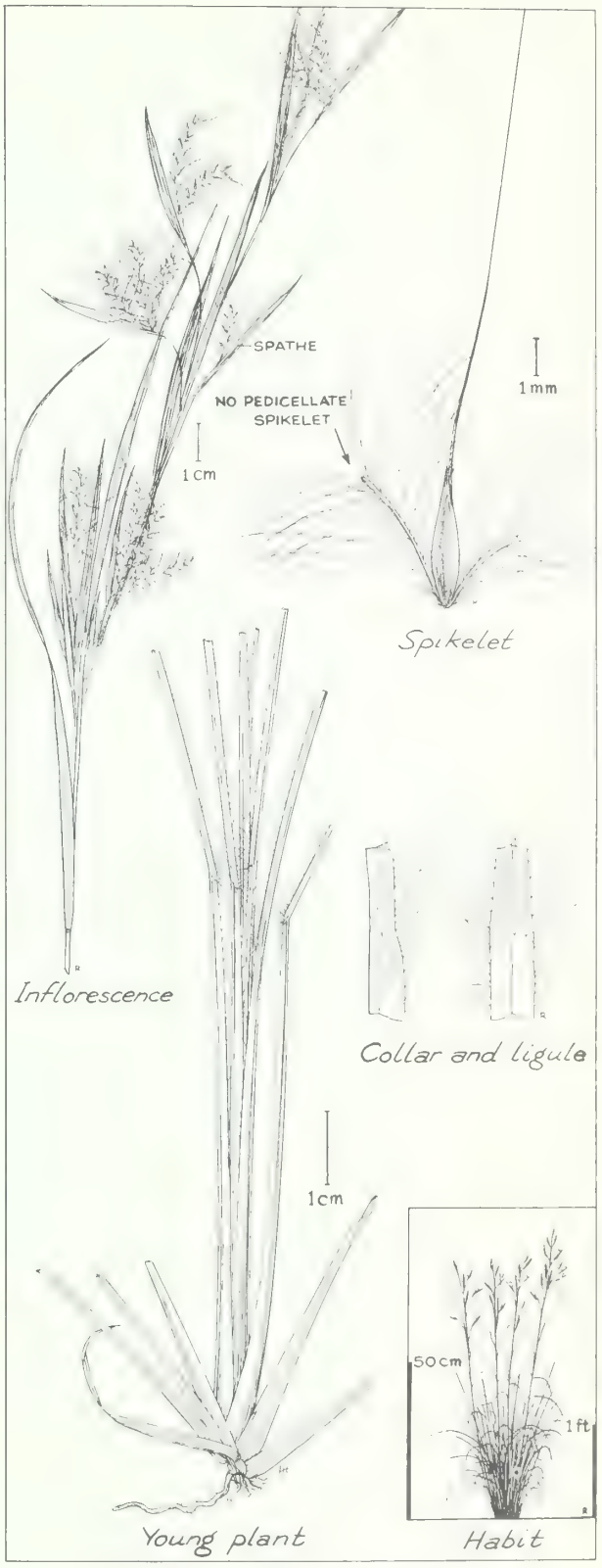
Although best known as an invader following disturbance, broomsedge occurs throughout the piney woods, even on ranges in excellent condition. It is most common on sandy sites, but grows on a wide range of soils. On cutover longleaf pine ranges it often inhabits stump holes.

Inflorescence branches are numerous, each bearing two to four slender silky racemes about 1 inch long. A spathe partly encloses each raceme. Elliott, fineleaf, and bushy bluestems are closely related to it, but usually broomsedge is distinguishable by its extremely flat basal sheaths and yellow-green or blue-gray color.

Broomsedge flowers later than the other bluestems and therefore remains palatable longer. When winters are mild, it yields green herbage yearlong. Except on wet sites and in abandoned fields, it is seldom abundant enough to contribute much forage. Where surface drainage is moderately slow, however, the glaucous form is valuable as forage, especially in the fall.

Range: Throughout most of the eastern half of the United States; also reported from California.

Perennial. **Culms** erect, 50-100 cm. tall, often in large tufts, simple at the base, branched above; **sheaths** shorter than the internodes, compressed, hirsute on the margins, otherwise glabrous and shining, conspicuously equitant and flat in mature plants, less so in young ones; **ligule** membranous, short, ciliate; **blades** flat or folded, 2-5 mm. wide, 15-40 cm. long, pilose on the upper surface near the base; **racemes** two to four, 2-3 cm. long, partly included and shorter than the coppery, slightly inflated spathes; **sessile spikelet** glabrous, 3 mm. long with an awn 1-2 cm. long; **pedicellate spikelet** generally obsolete, the pedicel long-silky-villous.



Broomsedge bluestem

BUSHY BLUESTEM

Andropogon glomeratus (Walt.) BSP.

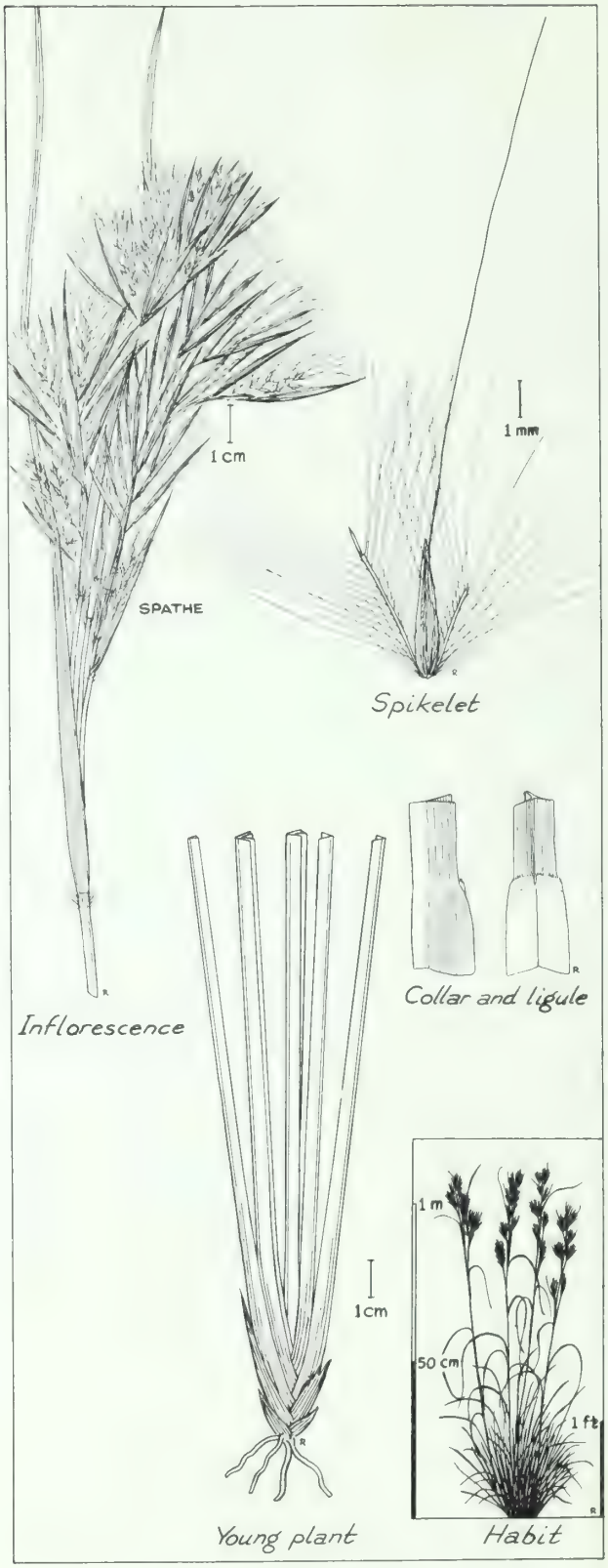
Bushy bluestem, a stout bunchgrass 2 to 5 feet tall, is confined to wet sites: ditchbanks, pond margins, marshes, and swamps. The inflorescence is a large, dense bundle of silky racemes with leafy spathes interspersed. Density of the seed head is due to its drastically shortened branches and internodes. Each of the many branches bears two racemes, the pair subtended by a spathe. Mature racemes are free from the spathes and equal to them in length.

The similar broomsedge bluestem, which is frequently associated with bushy bluestem, has smaller, less conspicuous heads. A variety of broomsedge bluestem, *Andropogon virginicus* var. *hirsutior* (Hack.) Hitchc., closely resembles bushy bluestem. Because this variety is not abundant, separating it is usually unimportant.

Bushy bluestem is not a valuable forage plant on longleaf pine-bluestem range. Since it occurs on sites seldom burned, the old growth reduces accessibility of green leaves.

Range: Southern California and Nevada east to Florida, Kentucky, and Massachusetts.

Perennial. **Culms** erect, stout, to 8 mm. thick, 50-150 cm. tall, compressed, bushy-branching above; **sheaths** longer than the internodes, flattened, rough, often pubescent in the throat, ciliate on the margins; **ligule** membranous, 1 mm. long, with a truncate, fimbriate margin; **inflorescence** dense, composed of a mass of slightly dilated spathes; **racemes** paired, 1-3 cm. long from spathes of about the same length; **sessile spikelet** 3-4 mm. long, the awn straight, 1-1.5 cm. long; **pedicellate spikelet** reduced to a single subulate glume, its pedicel and the rachis joint silky villous and about the same length as the sessile spikelet.



Bushy bluestem

ELLIOTT BLUESTEM

Andropogon elliottii Chapm.

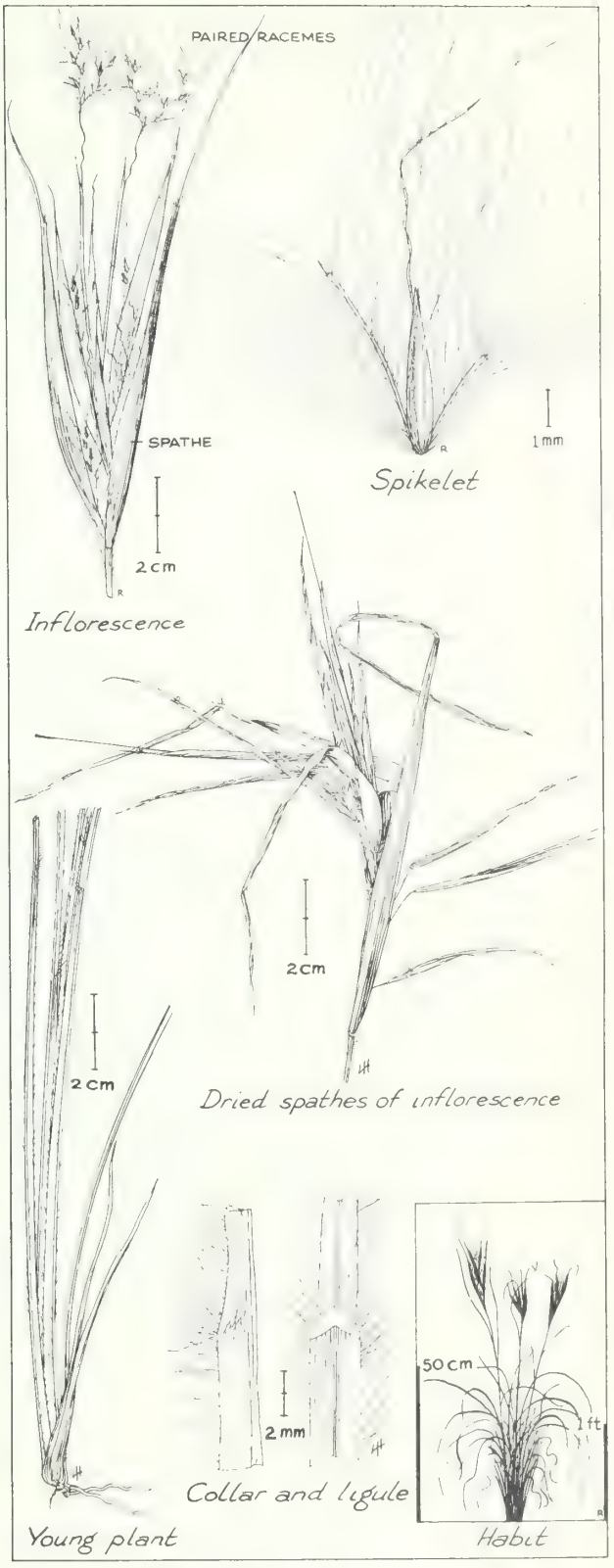
Elliott bluestem, although among the least abundant southern bluestems, is one of the most conspicuous. Toward maturity the large, inflated spathes that sheathe the inflorescence give the plants a topheavy appearance. Inner surfaces of these spathes are copper-colored, smooth and shining. On old fields and overgrazed range, Elliott bluestem may form almost pure stands but generally is widely scattered among other grasses. While it tolerates a wide range of sites, it is most common on dry, sandy soils. It is usually too scarce to contribute much forage.

The only southern grass easily confused with Elliott bluestem is fineleaf bluestem. The two species intergrade; plants are considered to be Elliott bluestem when they deviate from typical fineleaf bluestem. Therefore, height, leaf width, and inflorescence characteristics vary widely in Elliott bluestem. Typical plants are 2 to 3 feet tall with leaves about 12 inches long and 1/8 inch wide. The crowded spathes, with paired silky racemes either exserted or partially enclosed, are reliable identification. Dead stalks, with spathes attached, often persist through the winter.

Elliott bluestem resembles bushy bluestem in some respects. Both have crowded spathes, but those of bushy bluestem are not inflated. Habitats differ, bushy bluestem growing in wet areas and Elliott bluestem being generally confined to dry situations.

Range: Coastal Plain, Texas to New Jersey.

Perennial. **Culms** 30-80 cm. tall, in tufts, erect, simple at first, later branching toward the summit; **sheaths** shorter than the internodes, keeled, narrow, glabrous to loosely pilose; **ligule** short, a rounded membrane less than 1 mm. long; **blades** to 50 cm. long, flat, keeled, 1-7 mm. wide, glabrous to pilose, drooping and curling on drying; **racemes** 3-5 cm. long, paired, or rarely in threes or fours, the early ones long-exserted on flexuous peduncles from slender, inconspicuous spathes, the late ones in dense clusters on short peduncles within broad, green, purplish, or coppery spathes; **sessile spikelet** 4-5 mm. long, the awn loosely twisted, 10-25 mm. long; **pedicellate spikelet** rudimentary, the slender rachis joints and pedicels long-white-villous.



Elliott bluestem

FINELEAF BLUESTEM

Andropogon subtenuis Nash

Fineleaf bluestem is among the smallest southern bluestems. It is fairly common and widely distributed, but its low habit and narrow leaves make it relatively inconspicuous. It occupies a variety of sites, but grows best on well-drained ridges, mounds, and slopes. In cutover areas it may comprise 25 percent of the grass stand, but generally much less. Like slender bluestem, it tolerates heavier use than taller, broad-leaved grasses.

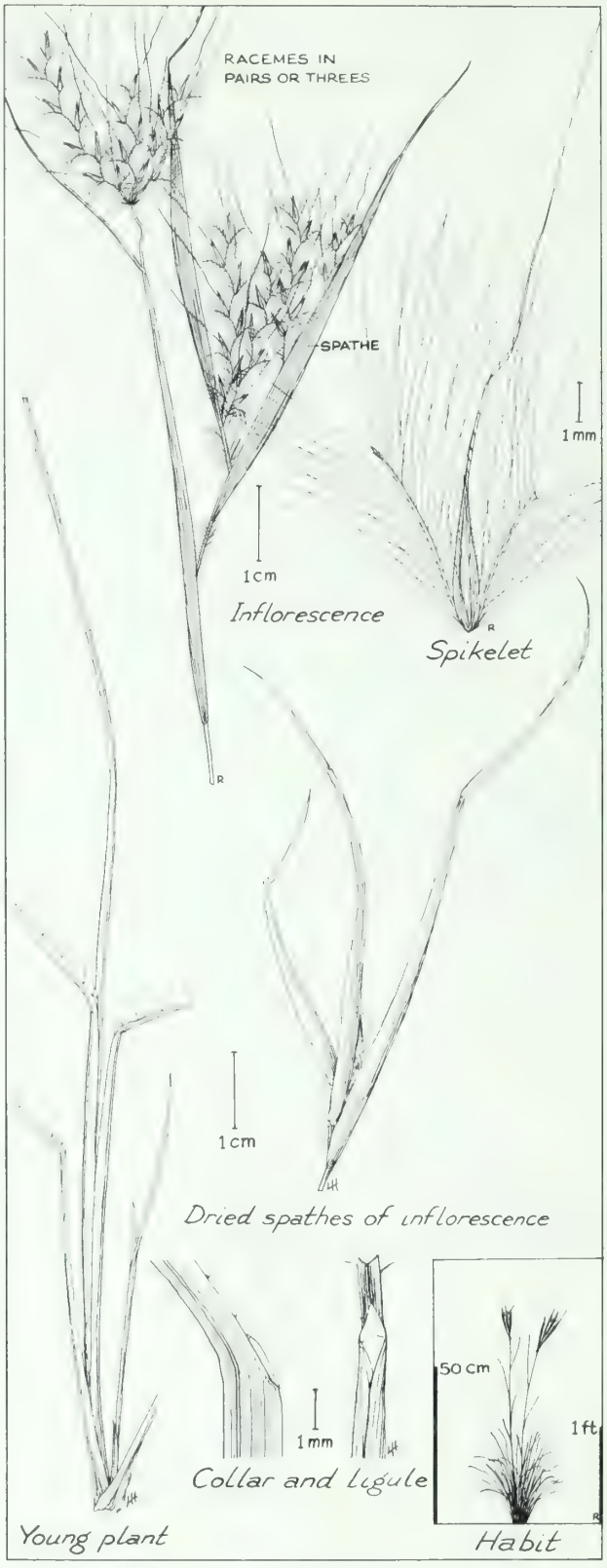
Mature plants are 16 to 28 inches tall and leaves are less than 1/8 inch wide. Lower leaf sheaths are laterally flattened, as in many bluestems. Foliage is similar to that of slender bluestem. Under a hand lens, fineleaf bluestem is distinguishable by its pointed ligule, the ligule of slender bluestem being short and blunt.

Seed heads are borne in slender, slightly inflated spathes, with at least some of the slender, silky racemes protruding. Seed heads may be confused with those of Elliott bluestem, which intergrades with fineleaf bluestem. Spathes of Elliott bluestem are distinctly inflated; they are also longer, more numerous, and more closely crowded.

In forage quality, fineleaf bluestem is similar to slender bluestem. Of the two, fineleaf bluestem matures later and therefore is more palatable in summer. Because plants are generally small and widely scattered, fineleaf bluestem is a minor part of the cattle diet.

Range: Louisiana to northern Florida.

Perennial. Culms erect, in small tufts, very slender, somewhat compressed, 40-70 cm. tall, sparingly branched above; **sheaths** keeled, wider than the blade, generally glabrous, but occasionally densely long-villous; **ligule** 0.5-1 mm. long, sharply pointed; **blades** 1.5-2 mm. wide, flat or folded, scabrous, generally with long scattered hairs on the margins near the ligule, occasionally densely long-villous as the sheaths; **racemes** two, 2-3 cm. long, flexuous, from slightly inflated spathes rarely over 7-10 cm. long; **sessile spikelet** 4 mm. long; **pedicellate spikelet** reduced to a tiny scale on a pedicel much longer than the sessile spikelet.



Fineleaf bluestem

PAINTBRUSH BLUESTEM

Andropogon ternarius Michx.

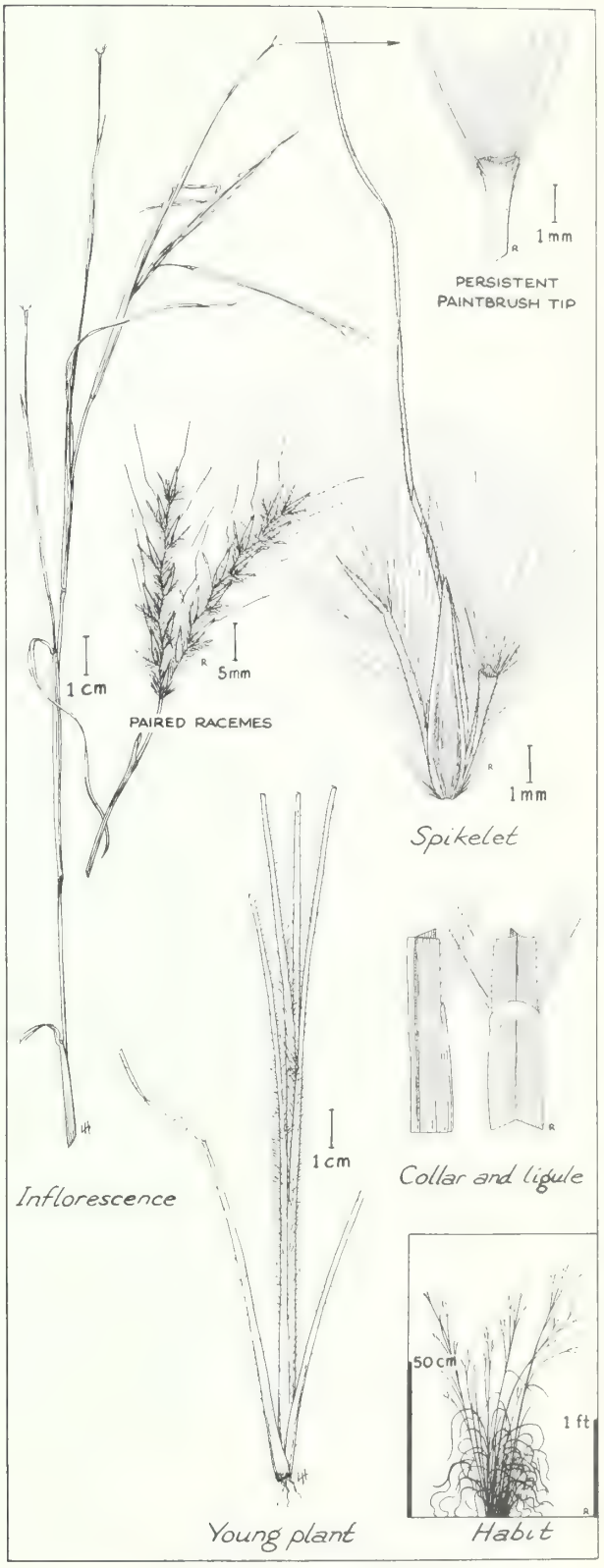
Paintbrush bluestem is a common associate of pinehill bluestem, especially on well-drained sandy sites. The two grasses look nearly alike until flower heads emerge in early fall. Racemes of paintbrush bluestem are paired, however, and are much thicker and showier than those of pinehill, which has only one raceme terminating each inflorescence branch.

During winter, spring, and summer, persistent old seedstalks are the best character for distinguishing paintbrush bluestem. A conspicuous paintbrushlike tuft of hairs remains on the branch tips after racemes shatter, and old-growth basal leaves are curly. It is also a true bunchgrass, while pinehill bluestem is rhizomatous.

Paintbrush bluestem is similar in forage value to pinehill bluestem. Because it is seldom abundant, however, it contributes little to the cattle diet.

Range: Coastal Plain, Delaware to Texas, and inland on dry, sandy soils to Kentucky and Kansas.

Perennial. **Culms** in tufts, 80-120 cm. tall, simple below and much branched above; **sheaths** shorter than the internodes, glabrous to densely hirsute near the base; **ligule** 1 mm. long, membranous; **blades** 2-4 mm. wide, the lower long and curling on drying; **racemes** in pairs, occasionally in threes, 3-6 cm. long, silvery-silky with long hairs, more or less exserted on long slender peduncles from slender spathes; **sessile spikelet** 5-6 mm. long, the twisted and bent awn 1.5-2 cm. long; **pedicellate spikelet** a scabrous scale 1 mm. long on a densely villous pedicel almost as long as the sessile spikelet.



Paintbrush bluestem

PINEHILL BLUESTEM

Andropogon divergens (Hack.)
Anderss. ex Hitchc.

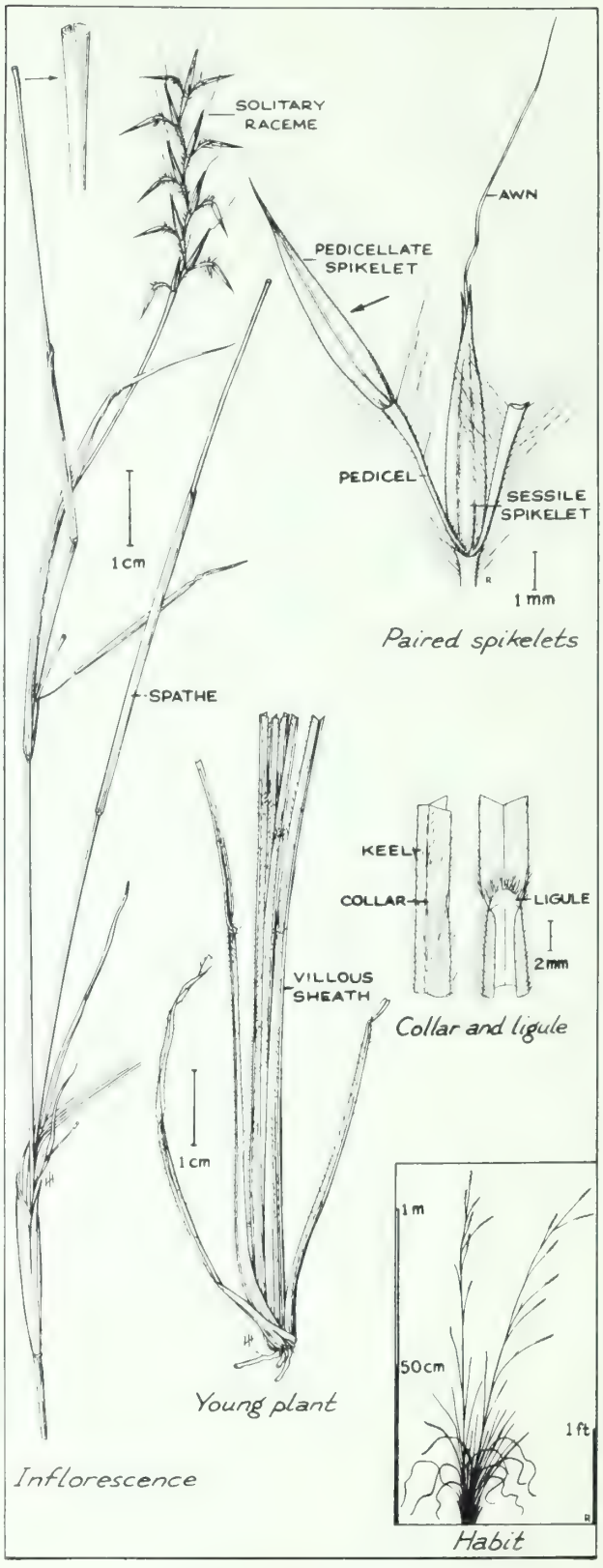
Pinehill bluestem is the most important forage grass on most ranges; therefore, it is the key management species. It grows on most upland sites, but produces best on well-drained soils. Unlike slender bluestem, its common associate, pinehill bluestem tolerates moderately dense shade. Hence, it is frequently the dominant grass under pine. On open land, it usually shares dominance with slender bluestem, the two often yielding more than half of the total herbage. Pinehill bluestem maintains abundance when moderately grazed but decreases under continuous heavy grazing.

Plants vary widely in appearance; some are extremely hairy, others practically hairless. Most specimens are green during the growing season, but some are grayish to chalky. Under average growing conditions, height is about 3 feet. Unless plants are crowded, basal leaves are usually numerous. The abundance of broad leaves probably accounts for the high preference cattle show for this grass.

Pinehill bluestem's nearest relative on pine forest ranges is little bluestem, *Andropogon scoparius* Michx. The two species are very similar in general appearance. Pinehill bluestem has short, rough, scaly rhizomes, however, while little bluestem is a true bunchgrass. In pinehill bluestem, the pedicellate and sessile spikelets are equal in length, and each has well-developed glumes, lemma, and palea. In little bluestem, however, the pedicellate spikelet is merely a rudimentary glume less than half as long as the sessile spikelet. Leaf blades of pinehill bluestem are about twice as long as those of little bluestem. Because of similar herbage yields, palatability, and nutritive values, the two bluestems may be considered as a single entity in management. Little bluestem is considerably the scarcer of the two species.

Range: Pinelands of Texas, Louisiana, Arkansas, and Mississippi.

Perennial. **Culms** 80-120 cm. tall, sparingly branched at the summit; **sheaths** crowded, pubescent to almost glabrous, often grayish-villous, compressed-keeled; **ligule** membranous, rarely more than 1 mm. long; **blades** 25-60 cm. long, 3-6 mm. wide, flat or folded, slightly scabrous, pubescent to villous, especially on the upper surface behind the ligule; **racemes** single, stout, 3-4 cm. long, mostly 6- to 8-jointed, partly enclosed in a spathe, on the end of a hollow, flared peduncle; **rachis joints** stout, long-ciliate on the upper half; **sessile spikelet** 6-8 mm. long, minutely roughened, the awn 5-10 mm. long; **pedicellate spikelet** as long as the sessile, composed of two sterile glumes, the first awn-tipped.



Pinehill bluestem

SLENDER BLUESTEM

Andropogon tener (Nees) Kunth

Slender bluestem is usually the most abundant grass on cutover longleaf pine lands. As the name suggests, it is fine-stemmed and narrow-leaved. The wiry flower stalks are up to 3 feet long, but have a sprawling habit. Hence plants rarely exceed 1.5 feet in height. Slender bluestem grows on a variety of sites, but is most productive on well-drained soils.

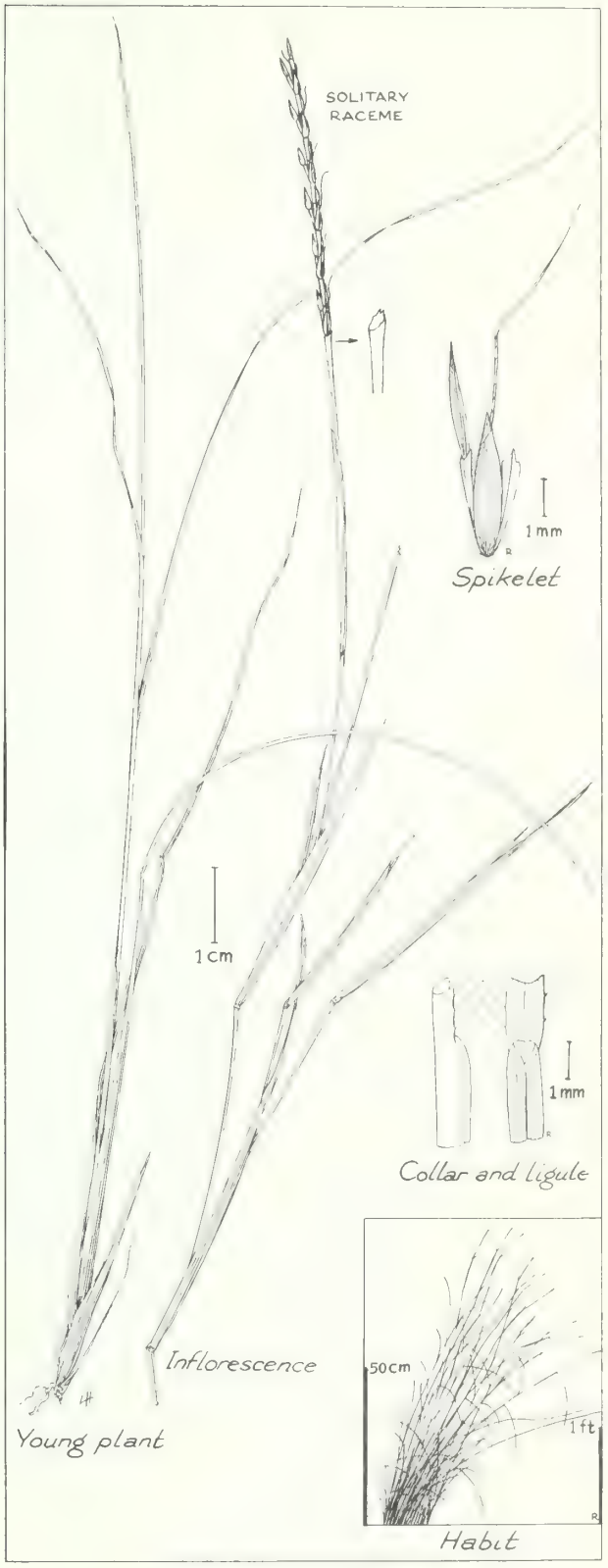
Each flower stalk branch bears a single, slim, practically hairless raceme about 2 inches long. The racemes begin appearing in early summer and shatter soon after maturity. Thereafter, plants can be identified by slightly enlarged tips of flower stalk branches.

Slender bluestem grows mixed with other grasses. In favorable years its dense mass of reclining seed-stalks obscures other species, creating an illusion of extensive pure stands. As it does not tolerate heavy shade, abundance decreases following reforestation of cutover lands.

On nontimbered sites, this grass is important in the cattle diet. It matures much earlier than most associated grasses and, unless grazed closely, becomes fibrous and unpalatable by midsummer. An accumulation of old growth not only discourages grazing but interferes with growth, thereby reducing herbage production. Where a heavy rough develops, burning may materially improve grazing value.

Range: Texas and Oklahoma to Florida and Georgia.

Perennial. **Culms** 60-100 cm. long, slender, in tufts, reclining, the upper half sparingly branched; **sheaths** shorter than the internode, broader than the blade, glabrous; **ligule** less than 1 mm. long, edge smooth; **blades** 1 mm. wide, flat or loosely involute, glabrous except for sparse, fine hairs at the base; **racemes** 2-6 cm. long, glabrous, solitary, on long peduncles with slightly flared, toothed, cup-shaped tip; **sessile spikelet** 4-5 mm. long, the awn 7-10 mm. long, twisted and bent; **pedicellate spikelet** of two awnless, empty glumes 4-5 mm. long.



Slender bluestem

PANICUMS

Panicum spp.

On longleaf pine-bluestem range, panicum species are more numerous than any other grasses. About 70 species occur in Louisiana alone. Collectively, they produce about 10 percent of the total herbage on longleaf pine-bluestem ranges. The foliage of most species is eaten readily by cattle during spring and summer. In mild winters, the thick, green rosettes of several panicums are an important food of both livestock and deer. The hard, smooth grains are valuable food for game birds.

Southern panicums may be classed in two broad, dissimilar groups: the "true" panicums, which flower once yearly and whose vegetative appearance does not change during the growing season; the "low" panicums, which flower in spring and again in late summer and have distinct winter, spring, and fall phases.

Key to panicum grasses

1 PLANTS WITH SCALY RHIZOMES, PRODUCING ONLY ONE TYPE OF UNBRANCHED CULM AND PANICLE; WITHOUT WINTER ROSETTES

2 Spikelets green or purplish on an open or contracted, large, well-branched panicle; plants 1-2 m. tall

P. virgatum, switchgrass→

2 Spikelets yellow green, set obliquely on their pedicels in a large, simply branched panicle; plants 50-100 cm. tall

3 Panicles open, branches generally long and sparse; spikelets 3 mm. or longer

P. anceps, beaked panicum→

3 Panicles more or less contracted, bushy, generally with shorter branches; spikelets less than 3 mm. long

P. rhizomatum→

1 PLANTS WITHOUT RHIZOMES, PRODUCING TWO OR MORE TYPES OF CULMS AND PANICLES; WITH WINTER ROSETTES

4 Culms and sheaths wholly glabrous or only inconspicuously pubescent, nodes rough to sparsely hairy; panicle axis glabrous; ligule either obsolete or of hairs less than 2 mm. long

5 Blades glabrous, thick, white-margined, cordate-clasping and ciliate at the base; spikelets spherical, not over 1.8 mm. long;
VERNAL PHASE radiate, spreading to nearly erect, 20-80 cm. tall;
AUTUMNAL PHASE prostrate-spreading, sparingly branched from middle and lower nodes;
WINTER ROSETTE of many thick, ovate-lanceolate, white-margined blades

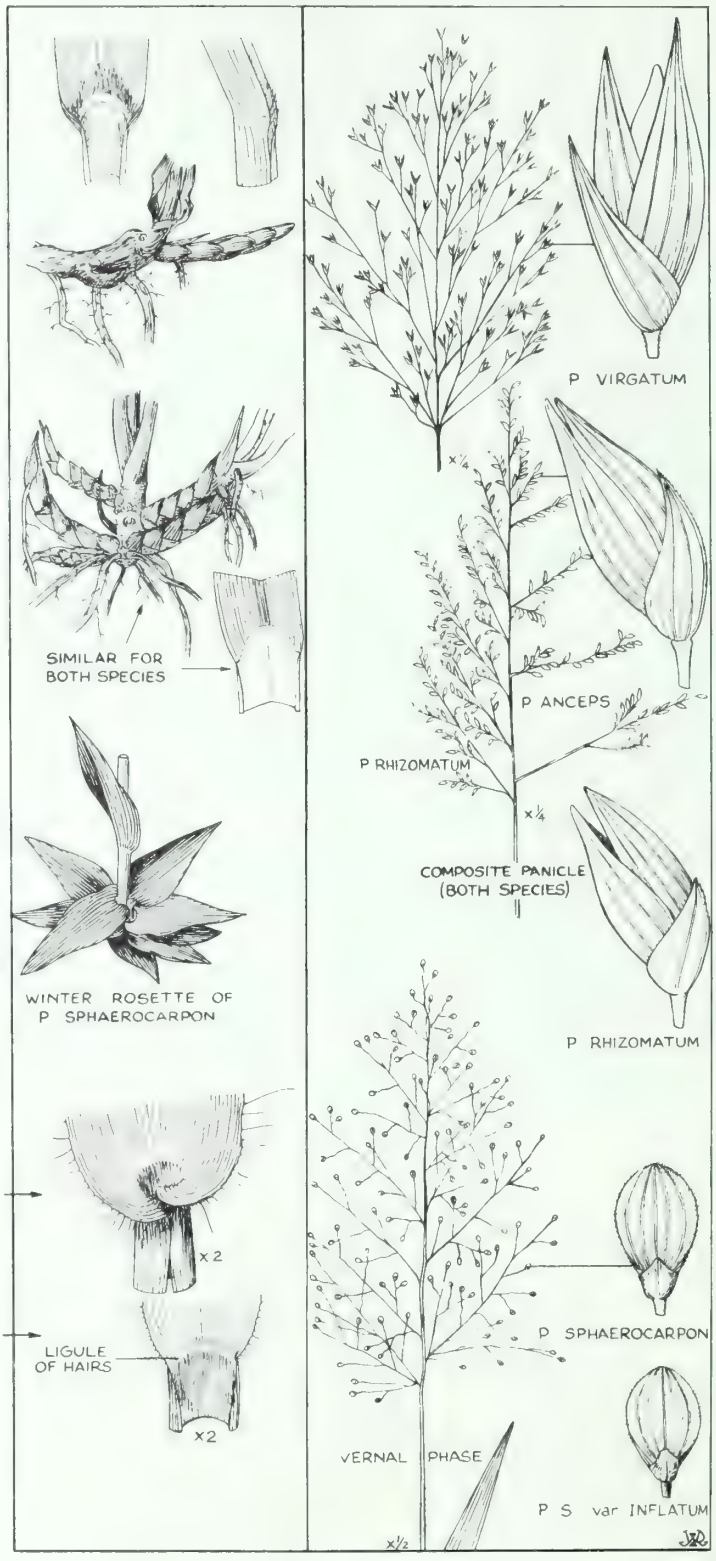
6 Ligule obsolete or nearly so; blades lanceolate, spikelets 1.6-1.8 mm. long

P. sphaerocarpon, roundseed panicum→

6 Ligule up to 1 mm. long; blades linear-lanceolate; spikelets 1.4-1.5 mm. long.

P. s. var. *inflatum*→

5 Blades sometimes papillose-pubescent beneath, thin, narrow, not white-margined, neither cordate-clasping nor ciliate at the base; spikelets ellipsoid, 1.8-2.8 mm. long;



VEGETATIVE CHARACTERS or AUTUMNAL PHASE

INFLORESCENCE CHARACTERS PANICLE ×½ SPIKELET ×10

VERNAL PHASE erect, slender, culms 30-50 cm. tall; panicle branches sinuous;

AUTUMNAL PHASE ascending to somewhat top-heavy, reclining; branching from the upper and middle nodes;

WINTER ROSETTE of short, broad, cordate, hairy-margined blades

P. angustifolium, narrowleaf panicum

4 Culms and sheaths conspicuously velvety pubescent, pilose or villous; nodes densely long-hairy; panicle axis pubescent; ligule of hairs 2-5 mm. long

7 Spikelets no longer than 2 mm.

8 Spikelets 1.8-1.9 mm. long;

VERNAL PHASE grayish olive green, velvety, slender, lax, and spreading;

AUTUMNAL PHASE widely spreading or decumbent, freely branching from the middle nodes, these branches dividing often to produce fan-like fascicles of reduced blades;

WINTER ROSETTE of several elongate ciliate or velvety to nearly glabrous blades

P. lanuginosum, woolly panicum

8 Spikelets 2 mm. long;

VERNAL PHASE bluish green, drying olive, villous, erect, at first simple, branching later, nodes bearded usually with a glabrous ring below;

AUTUMNAL PHASE erect, bearing a few appressed fascicled branches from the middle nodes;

WINTER ROSETTE of long, ciliate blades

P. thurowii

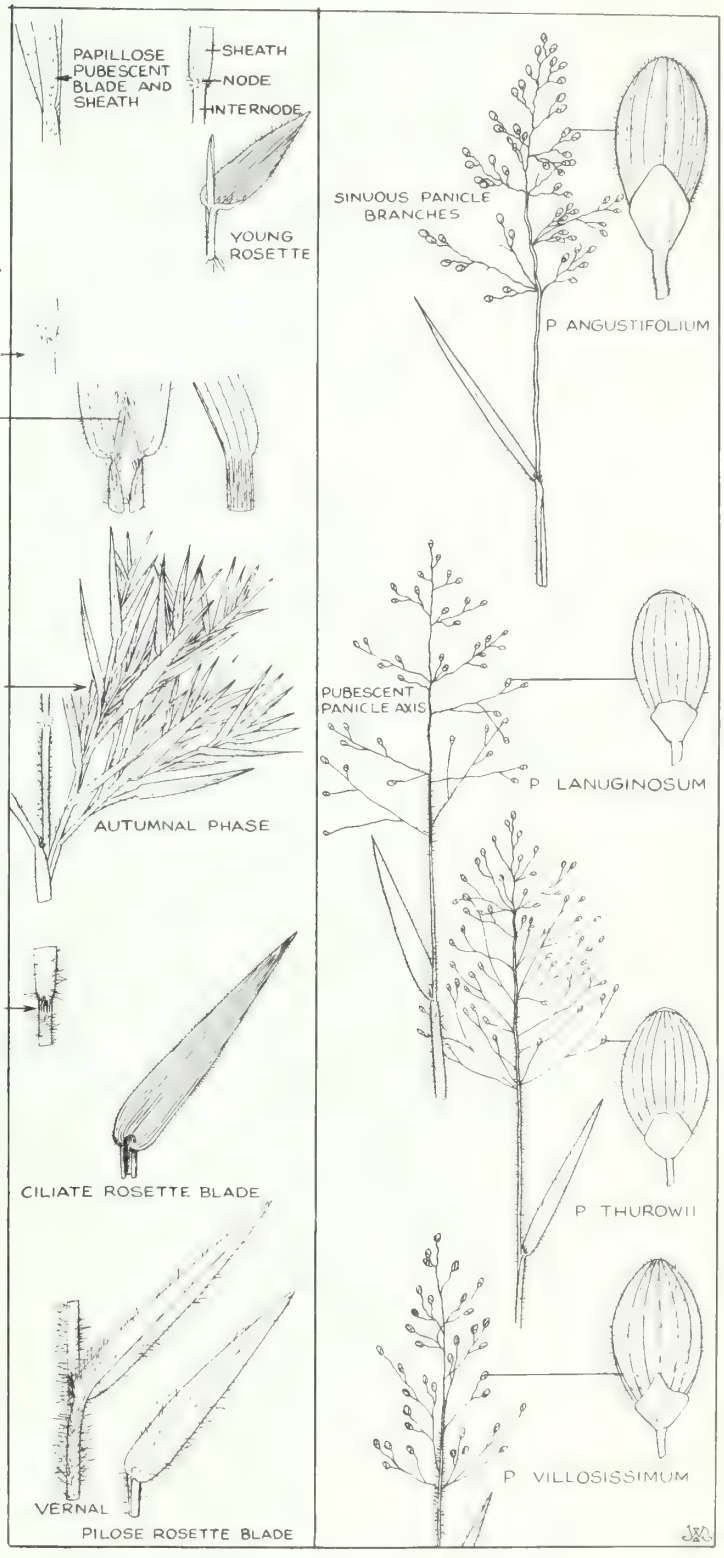
7 Spikelet 2.2-2.3 mm. long;

VERNAL PHASE light olive green, pilose with spreading hairs, slender, erect;

AUTUMNAL PHASE at first decumbent, later prostrate, blades of the fascicled branches appressed, not greatly reduced;

WINTER ROSETTE of many elongate blue-green, densely pilose blades

P. villosissimum



NARROWLEAF PANICUM

Panicum angustifolium Ell.

Narrowleaf panicum, one of the "low" species, grows throughout the longleaf pine-bluestem type. While usually most abundant on open land, it is moderately tolerant of shade.

It forms a winter rosette and has distinct spring and fall phases. Leaf blades of winter rosettes are hairy on the margins. In the spring form, which persists through much of the growing season, the upper leaf sheaths are practically hairless. Although spring leaves are 3 to 5 inches long and usually less than 1/4 inch wide, lowermost leaves—actually those of the winter rosette—are much shorter and distinctly wider. Spring plants are erect, with seedstalks reaching about 20 inches high. Fall leaves, in crowded, fan-shaped clusters, are miniatures of the spring leaves, and are practically hairless.

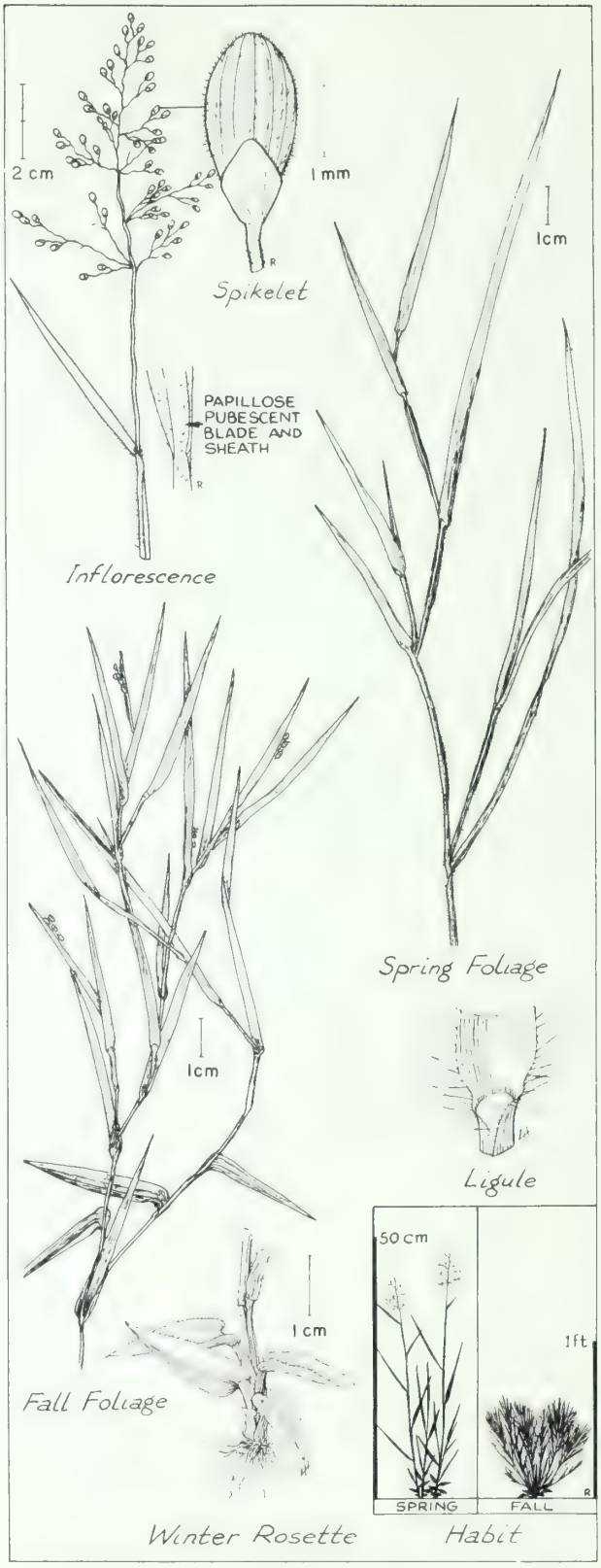
Spring flower stalks, 12 to 20 inches tall, are terminated by a panicle 1½ to 4 inches long. Fall flowers are produced in numerous small panicles, largely obscured by foliage. In both spring and fall phases, spikelets are about 1/16 inch long. They are covered with very short white hairs that may be visible only under magnification.

Range: Coastal Plain, east Texas to northern Florida and Virginia.

Perennial with three phases. **Vernal culms** 30-50 cm. tall, erect, from a winter rosette of short, thick, glabrous blades with ciliate margins, lowermost internodes gray-villous, the middle and upper glabrous, nodes glabrous; **lower sheaths** appressed pilose, pubescent to villous, the upper glabrous; **ligule** a ring of hairs less than 1 mm. long; **blades** 5-15 mm. long, 4-8 mm. wide, stiffly ascending, long-acuminate, glabrous or papillose-ciliate near the base, villous to glabrous on both surfaces, lowest blades short and broad, as these are of the old rosette; **inflorescence** a long-exserted panicle 4-10 cm. long, loosely flowered, the branches sinuous, widely spreading at anthesis, the lower often reflexed; **spikelets** 2.5-2.8 mm. long, elliptical-obovoid, papillose-villous.

Autumnal phase culms ascending or somewhat top-heavy reclining, usually less than 20 cm. tall, not spreading or matlike; blades very numerous, flat, appressed, thin and papery; panicles reduced, the early ones exserted, the later ones of only a few hidden spikelets.

Winter phase a rosette of short, broad, cordate, hairy-margined blades.



Narrowleaf panicum

ROUNDSEED PANICUM

Panicum sphaerocarpon Ell.

Although roundseed panicum has the seasonal vegetational variations of the low panicums, its fall and spring phases do not differ drastically. Thus, fall leaves are not greatly reduced or crowded, and fall panicles are fully exserted above the leaves.

This panicum is widely distributed through the piney woods, mainly on sandy soils, in association with the bluestems. Like other low panicums, it yields little forage, but quality is good.

While resembling other low panicums, its relatively broad leaves and tiny spikelets set it apart. Spring leaves are mostly 2 to 4 inches long, lance shaped, and about ½ inch wide. Except for a few long white hairs at the leaf blade base, the plant appears almost hairless. Usually there is no ligule. When fully expanded, spring panicles are conical and 2 to 4 inches long. Spikelets are generally purple and about 1/16 inch long.

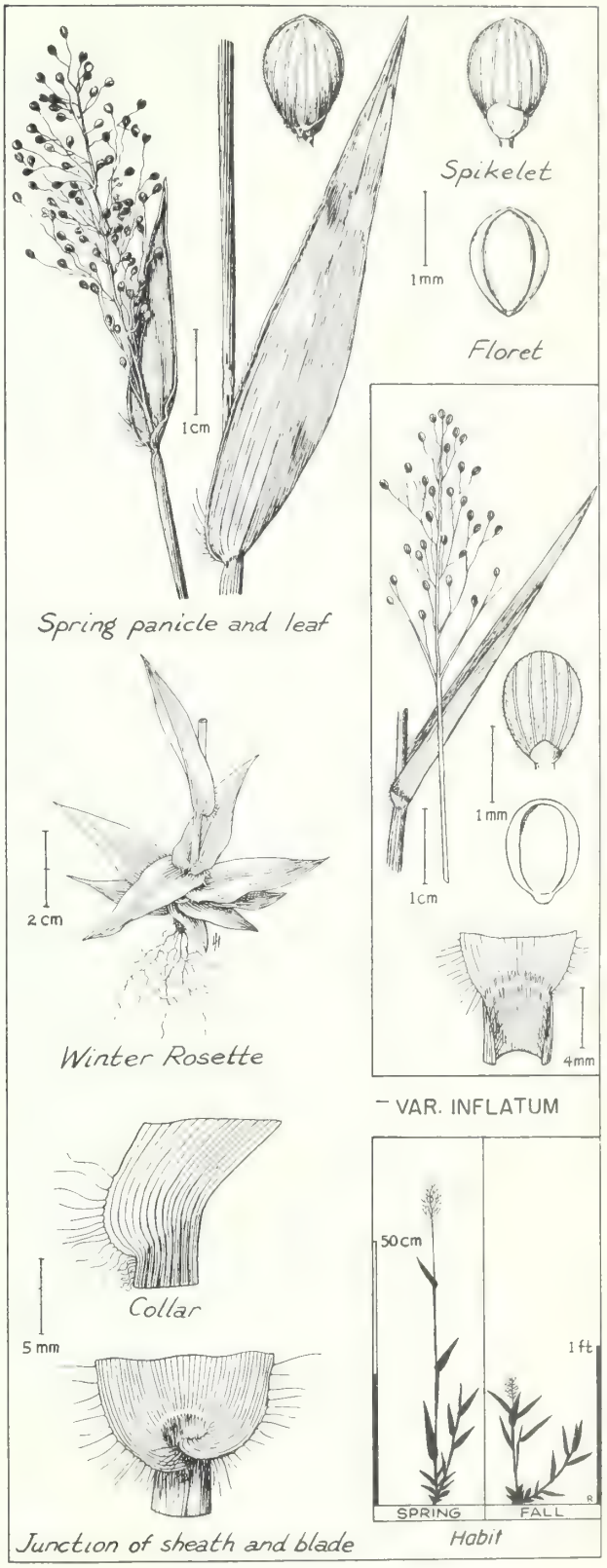
A variety, *P. sphaerocarpon* var. *inflatum* (Scribn. & Smith) Hitchc. & Chase, occurs and intergrades with typical roundseed panicum. The variety can usually be distinguished by its narrower, more nearly linear leaves with parallel margins, ligule with short hairs, and a freely branching fall phase.

Range: Practically the entire eastern half of the United States from Texas and northern Florida to Kansas and Vermont; also reported from Mexico to Venezuela.

Perennial. **Vernal phase** light green; **culms** 20-80 cm. tall, spreading, sometimes nearly erect, the nodes appressed-pubescent; **sheaths**, the upper shorter, the lower longer than the internodes, ciliate on the margin, sometimes with viscid tubercles between the nerves; **ligule** obsolete or nearly so; **blades** 5-10 cm. long, 7-12 mm. wide, the lowermost and uppermost shorter, thick, firm, acuminate, slightly narrowed to a subcordate base, margins cartilaginous and stiffly ciliate, often papillose; **inflorescence** a long-exserted panicle 5-10 cm. long, nearly as wide, the axis and ascending branches with viscid spots; **spikelets** 1.6-1.8 mm. long, dark purple, puberulent; **first glume** about ¼ the length of the spikelet; **second glume** and **sterile lemma** equaling the fruit at maturity, five to seven nerved; **floret** white.

Autumnal phase erect to prostrate-spreading, sparingly branching late in the season, from the base or lower or middle nodes, branches short and mostly simple.

Winter rosette appearing early, blades ovate to ovate-lanceolate with white margins.



Roundseed panicum

WOOLLY PANICUM

Panicum lanuginosum Ell.

Woolly panicum is most abundant on moist, sandy soils. Like low grasses in general, it withstands heavier grazing than most tall species. It is grazed mainly in winter and early spring, when other green forage is scarce.

Plants have three seasonal phases. The winter phase is a rosette with leaves about 1 inch long and ¼ inch wide. In the spring phase, blades are 2 to 4 inches long, about ¼ inch wide, and spaced alternately along erect stems that may reach 2 feet. Each stem terminates in a panicle 2 to 4 inches long. Whereas fall and winter foliage is only slightly hairy, the leaves, stems, and spikelets of the spring phase are conspicuously hairy. In the fall phase, leaves are about 1 inch long and ⅛ inch wide. Densely clustered at the branch tips, they practically conceal the terminal panicles, which are about 1 inch long.

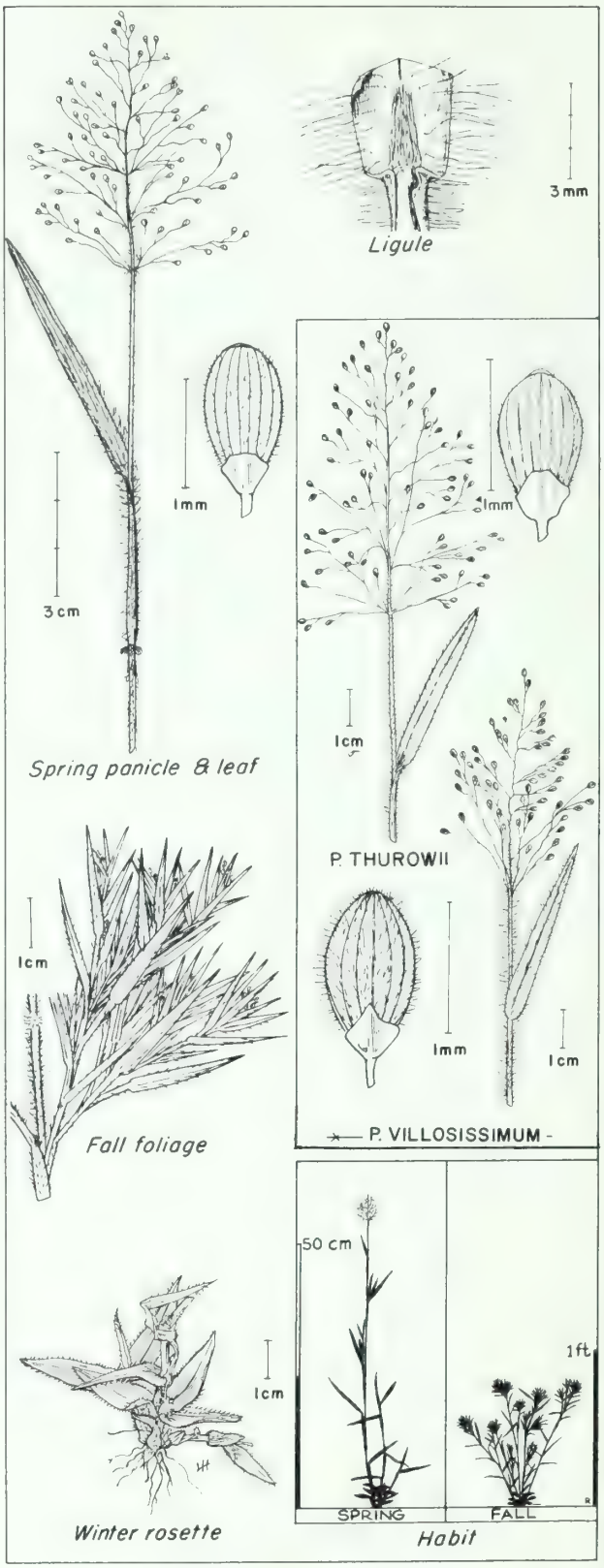
Other panicums may closely resemble woolly panicum. Two of these, *P. thurowii* Scribn. & Smith and *P. villosissimum* Nash, can be distinguished only by careful taxonomic study. They generally grow on drier sites than woolly panicum, but the three are probably associated in some areas. For practical purposes, all can usually be classed as woolly panicums.

Range: Texas and Arkansas to Florida and Tennessee.

Perennial. **Vernal phase** grayish olive green; **culms** 40-70 cm. tall, in large clumps, slender, spreading, densely villous, nodes villous, often with a glabrous ring below; **sheaths** shorter than the internodes, soft-villous; **ligule** of hairs 2-5 mm. long; **blades** 5-10 cm. long, 5-10 mm. wide with the uppermost smaller, ascending or spreading, acuminate, upper surface of mixed short and long soft hairs, lower surface velvety pubescent; **inflorescence** an exserted panicle 6-12 cm. long with a slender, sinuous, pubescent axis, branches ascending or spreading; **spikelets** 1.8-1.9 mm. long, obovoid-elliptic, pubescent.

Autumnal phase widely spreading or decumbent culms, freely branching from middle nodes, branching repeatedly to form flabellate fascicles with much reduced blades.

Winter rosette blades 4-5 cm. long, usually ciliate, otherwise minutely velvety to nearly glabrous.



Woolly panicum

SPREADING PANICUM

Panicum rhizomatum Hitchc. & Chase

Spreading panicum grows on wet sites throughout pine forests of the lower Coastal Plain. It commonly inhabits poorly drained flats, shallow depressions, drainageways, and stump holes.

Like other true panicums, it lacks distinct seasonal phases, and it flowers only once a year. Seedstalks are generally less than 3 feet tall, from long, slender rhizomes. Basal leaves are usually numerous; the blades measure about ½ inch wide and a foot or more in length. Close grazing causes basal tufts to spread widely, the prostrate leaves forming a dense sod over small areas.

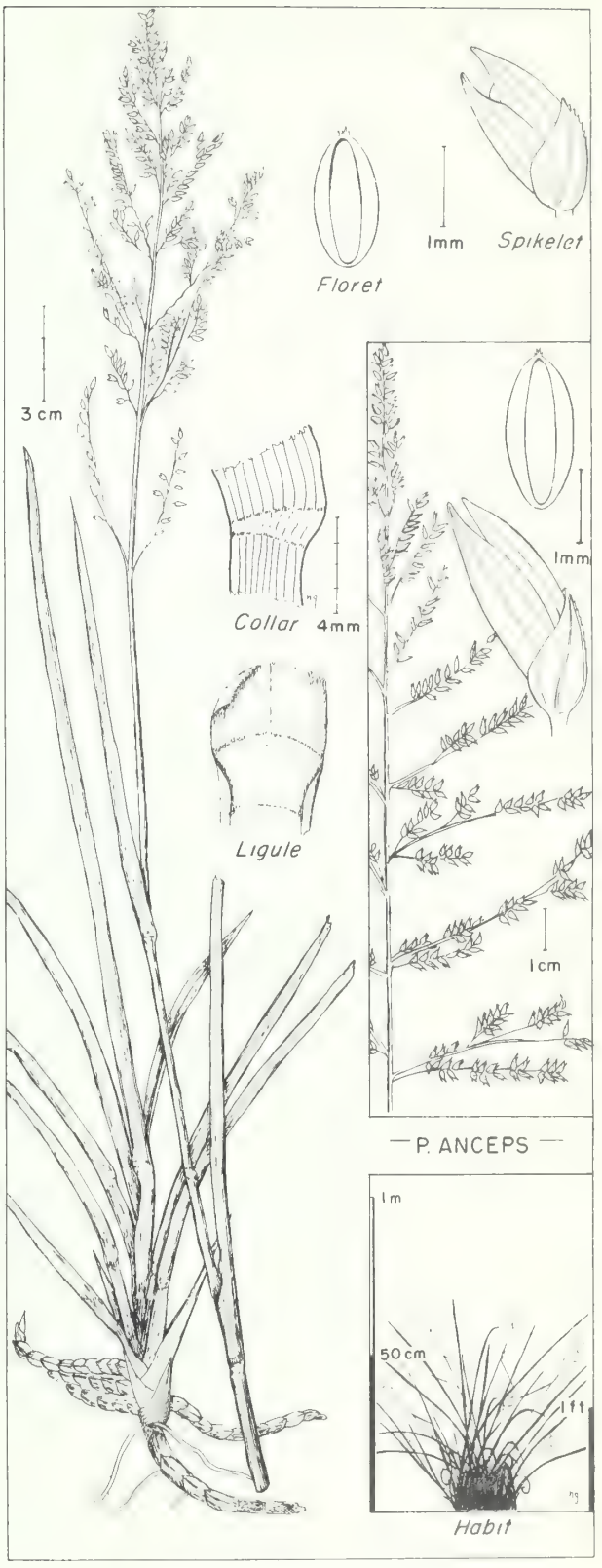
Although it closely resembles beaked panicum, *Panicum anceps* Michx., it is neither as tall nor as stout. Its panicles are less than 1 foot long and usually laterally contracted; those of beaked panicum often exceed 1 foot and have spreading branches. While spikelets of spreading panicum are less than ⅛ inch long, those of beaked panicum reach ⅛ inch or longer.

Gaping panicum, *Panicum hians* Ell., grows on the same sites as spreading panicum and beaked panicum. Although the three species are similar in several respects, spikelets of the first two sit obliquely on pedicel tips; those of gaping panicum sit straight with the pedicel axis. Gaping panicum has no rhizomes.

Spreading panicum is readily eaten by cattle. Even on moderately grazed range, plants usually are closely utilized. The species withstands heavy use, but is rarely abundant except on small areas, and hence contributes only small quantities of forage.

Range: Coastal Plain from Texas to Florida, north to Maryland, inland to Tennessee.

Perennial. **Culms** 50-100 cm. tall, compressed, from slender, scaly rhizomes; **sheaths** crowded at the base, glabrous to densely papillose-villous, particularly villous at the collar; **ligule** short, almost obsolete, with a dense area of hairs above it; **blades** 10-40 cm. long, erect or spreading, 5-10 mm. wide, glabrous to villous on both surfaces; **inflorescence** a terminal panicle 10-25 cm. long, somewhat contracted and densely flowered; **spikelets** 2.4-2.8 mm. long, obliquely set on their appressed, scabrous pedicels; **first glume** 1/3-1/2 as long as the lemma, with a prominent scabrous keel; **second glume** and **sterile lemma** subequal, slightly beaked; **floret** about 1.9 mm. long, ovoid, pale and shining, tipped with a group of minute, thick spines.



Spreading panicum

SWITCHGRASS

Panicum virgatum L.

Switchgrass is one of the true panicums, having no seasonal phases and flowering only in late summer or early fall. It is among the tallest and stoutest panicums in the South, reaching 6 to 7 feet.

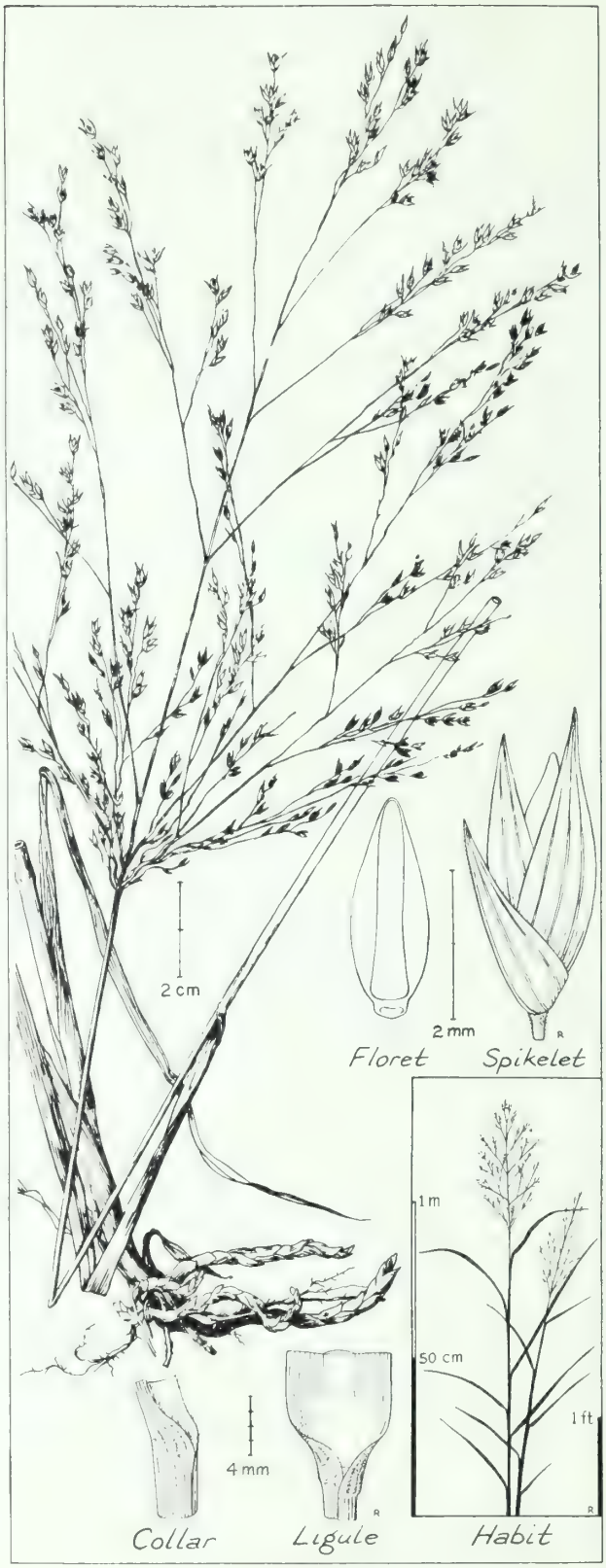
Because plants spread by numerous scaly rhizomes, switchgrass often forms large, dense colonies. It is usually sparse on well-drained range sites, but on moderately wet soils it may be the predominant grass. Tolerance of shade renders this grass potentially important for grazing under young pines and in stands that have been thinned several times. Before foliage matures, cattle prefer it to most associated species. Where it comprises a minor part of the forage, therefore, it is overgrazed. Switchgrass also has value for wildlife. Birds eat the seeds, and deer reportedly paw up and eat the rhizomes when winter food is scarce.

Plants are generally hairless except for dense white hairs at the ligules and scattered hairs on the bases of leaf blades. The inflorescence is an open panicle ½ to 1½ feet long with ascending branches. Panicles persist on stiff, stout flower stalks through the winter and well into the next growing season, providing a reliable guide to identification in summer. Spikelets are up to 3/16 inch long, among the largest in southern panicums.

Ordinarily, switchgrass is not easily confused with other common grasses of the longleaf pine-bluestem type. Beaked panicum and spreading panicum, though similar in form, are usually smaller throughout. Switchgrass is highly variable, however, and small, fine-textured specimens may be encountered. These are distinguishable from other panicums by the gleaming white midribs of their leaf blades and their satiny sheath linings. While foliage of switchgrass resembles that of yellow indiangrass, the latter can be identified by prominent auricles at its leaf collars.

Range: Throughout the United States, except Idaho, Montana, and the Pacific States.

Perennial. **Culms** 1-2 m. tall, terete, robust, erect, solitary or in clumps from long, hard, scaly rhizomes; **sheaths** green to purple-tinged, often glaucous, gleaming white within, mostly glabrous, though sometimes pilose; **ligule** membranous-ciliate, a pale tan to brown membrane 1-2 mm. long with a dense mass of fine, white hairs on the back and arising from it, 3-4 mm. to 7 mm. long, in age the membrane sloughing off to leave a dense ring of hairs; **blades** 3-15 mm. wide, often glaucous, 10-60 cm. long, with a prominent, wide, white midrib, ascending, taper-pointed, mostly glabrous but sometimes pubescent to pilose on both surfaces, margins scabrous; **inflorescence** a long-exserted open panicle 15-50 cm. long with ascending branches; **spikelets** 3.5-5 mm. long, ovoid, acuminate, with prominent nerves; **first glume** shorter, **second glume** longer than the sterile **lemma**; **floret** narrowly ovoid, 2.6-3.8 mm. long or about ¾ the length of the spikelet.



Switchgrass

PASPALUMS

Paspalum spp.

The native paspalums, though rarely abundant, are often conspicuous in the range vegetation. Florida paspalum, which is probably the most plentiful, ranks among the tallest native grasses. Brownseed paspalum and fringeleaf paspalum are common. At least two introduced species are widely used as forage. Dallisgrass, *Paspalum dilatatum* Poir., is seeded on improved pasture. Vaseygrass, *P. urvillei* Steud., is a common roadside weed sometimes grown for hay. Since these two species sometimes escape to the range, they have been included in the key.

Key to paspalum grasses

HABIT & HEIGHT, cm. | LEAF, LIGULE ×2 AND BASE ×1/3 | RACEME X2/3 or 1/3 | SPIKELET ×7.5

1 CULMS ARISING FROM SHORT, SCALY RHIZOMES

2 Plants robust, 1-2 m. tall; sheaths hairy; racemes 2-5, ascending; spikelets green, glabrous, 4 mm. long

P. floridanum, Florida paspalum→

2 Plants not robust, mostly less than 1 m. tall, sheaths generally glabrous, racemes 3-8, spreading; spikelets brown at maturity, glabrous, 2.5-2.8 mm. long

P. plicatulum, brownseed paspalum→

1 CULMS NOT ARISING FROM SCALY RHIZOMES, BUT GROWING IN TUFTS OR CLUMPS, WITH OR WITHOUT KNOTTY BASAL PARTS

3 Spikelets glabrous, not ovate-pointed; plants 1 m. or less in height

4 Spikelets green; blades strongly ciliate, racemes 1-3

P. ciliatifolium, fringeleaf paspalum→

4 Spikelets brown; blades not ciliate; racemes 3-10

P. plicatulum (see above)

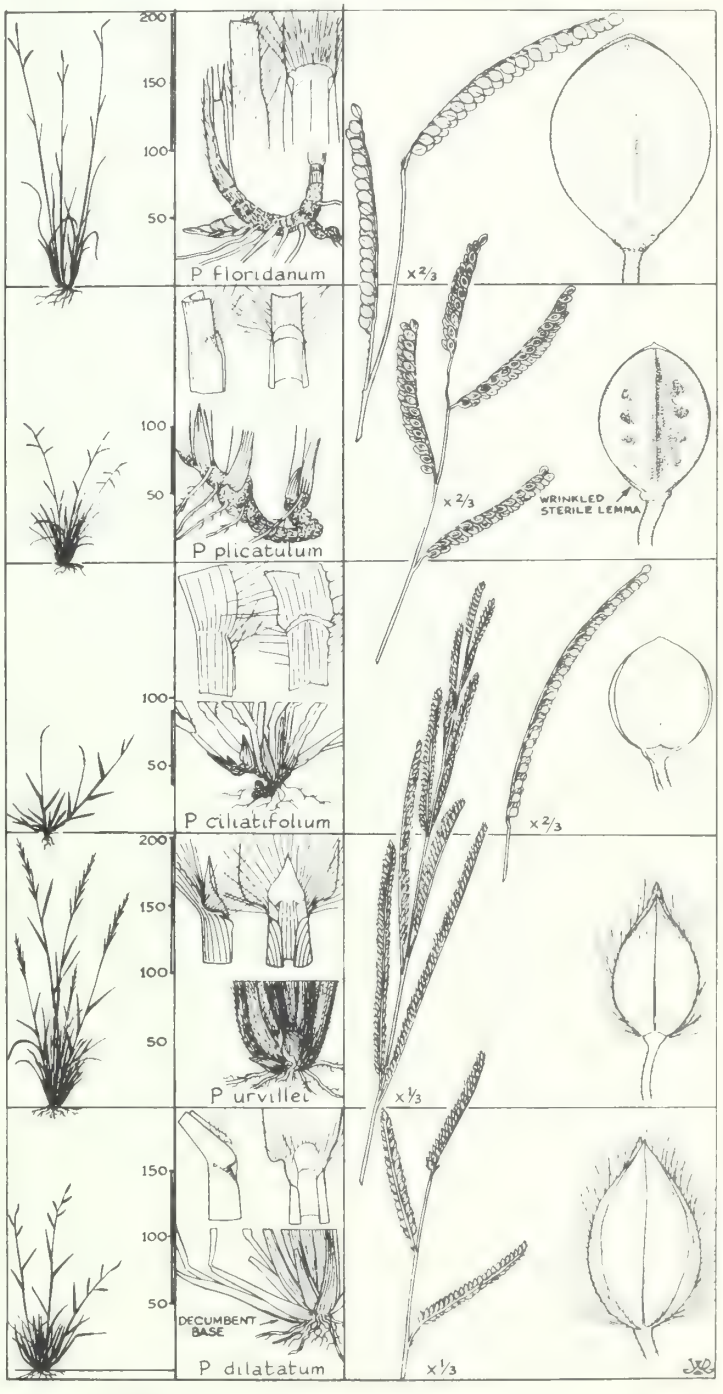
3 Spikelets fringed with long, silky hairs, ovate-pointed; plant usually more than 1 m. tall

5 Racemes 12-20, ascending, crowded; spikelets 2.2-2.7 mm. long, sheaths hirsute, frequently papillose, purplish in color

P. urvillei, vaseygrass→

5 Racemes 3-5, spreading, not crowded; spikelets 3.0-3.5 mm. long; sheaths usually glabrous, the lower sometimes harshly pilose at the base

P. dilatatum, dallisgrass→



The paspalum inflorescence usually consists of one to several racemes, each with spikelets in rows along the lower side. In prevalent native species, only one raceme originates from a given point on the main axis. These often protrude in a common direction, making the inflorescence one sided. Grains are flat on one side, convex on the other. Although paspalums are not always readily distinguishable from related grasses, these characters usually suffice to identify the genus.

Flowers of paspalums are often infected by ergot, *Claviceps paspali*, a fungus that attacks and destroys the grain. Other fungi grow on the honeydew exuded by ergot and produce a variety of colors in the seed heads. The black, horny bodies that develop in place of the seeds are toxic to cattle. On properly managed ranges, danger of ergot poisoning is slight, as paspalums usually comprise a small part of the diet.

BROWNSEED PASPALUM

Paspalum plicatulum Michx.

Brownseed paspalum grows in forest openings and on cutover lands throughout the longleaf pine-bluestem type. It intrudes where the soil has been disturbed and on areas that have been heavily grazed. Preferred sites include wet meadows, drainageways, and roadside ditches, where plants spread by rhizomes to form dense colonies. It is rare under well-stocked timber stands.

Plants produce many seedstalks averaging 3 feet tall. Each stalk bears several slender racemes 1 to 4 inches long. Spikelets are in two rows on the lower side of a flattened, zigzag axis. Grains are about 1/8 inch long, medium to dark brown, and shiny. In mature plants, grain color readily distinguishes brownseed paspalum from other paspalum grasses. Foliage is green to distinctly blue green. Leaves are firm to wiry, with blades up to 18 inches long.

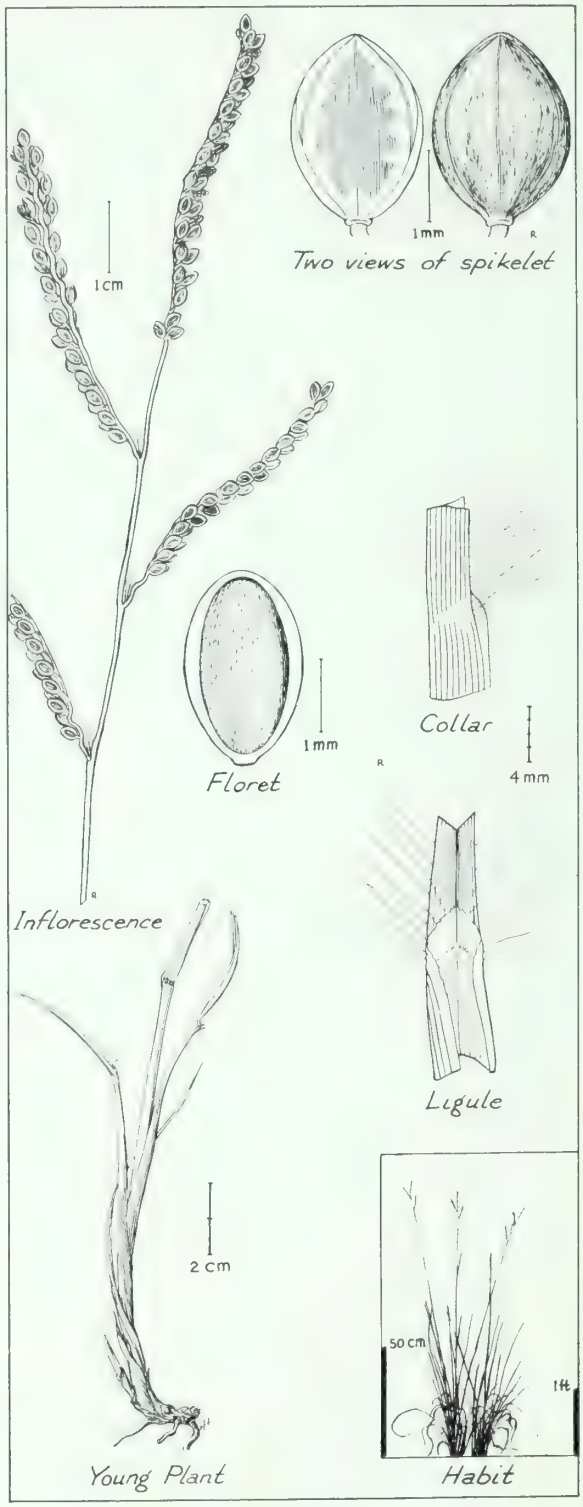
The abundance of brownseed paspalum along roadways and firebreaks may exaggerate its importance. Plants are sparse on most range sites; thus, this species normally contributes only a minor part of the cattle diet. The foliage becomes tough and low in palatability by midseason, but because leaves frequently remain green through much of the winter, cattle may eat large amounts after frost kills back other grasses.

Extensive stands should not be grazed when spikelets are heavily infected with ergot. Grazing may be resumed with little risk after seed heads shatter.

Game birds eat the grain, but ergot makes the supply unreliable.

Range: Coastal Plain, Texas to Florida and Georgia.

Perennial. **Culms** 50-100 cm. tall, in tufts with many leafy shoots, erect or ascending from a slightly decumbent base; **sheaths** keeled, the lower crowded, glabrous to papillose-pilose along margins and keel, or rarely hirsute throughout; **ligule** a pointed, pale-brown membrane 2-3 mm. long; **blades** 8-45 cm. long, 3-10 mm. wide, basal ones folded, upper ones flat and usually greatly reduced in length, glabrous, but pilose at the base; **inflorescence** of three to eight racemes, each 3-10 cm. long; **spikelets** 2.5-2.8 mm. long, ovoid, brown at maturity; **first glume** wanting; the glabrous or appressed-pubescent **second glume** and transversely wrinkled **sterile lemma** equal, both thin and five-nerved; **grain** 2.3-2.5 mm. long, ovoid, brown, and shining.



Brownseed paspalum

FLORIDA PASPALUM

Paspalum floridanum Michx.

Florida paspalum is among the most robust grasses on longleaf pine-bluestem range. It averages about 3 feet tall, but may reach 6 feet or more. Leaves, which are mostly basal, ascend stiffly. Blades are up to 20 inches long and 3/8 inch wide. The dark green foliage is usually densely hairy, but occasional specimens are almost hairless. Each stalk has two to five thick racemes, each about 3 inches long.

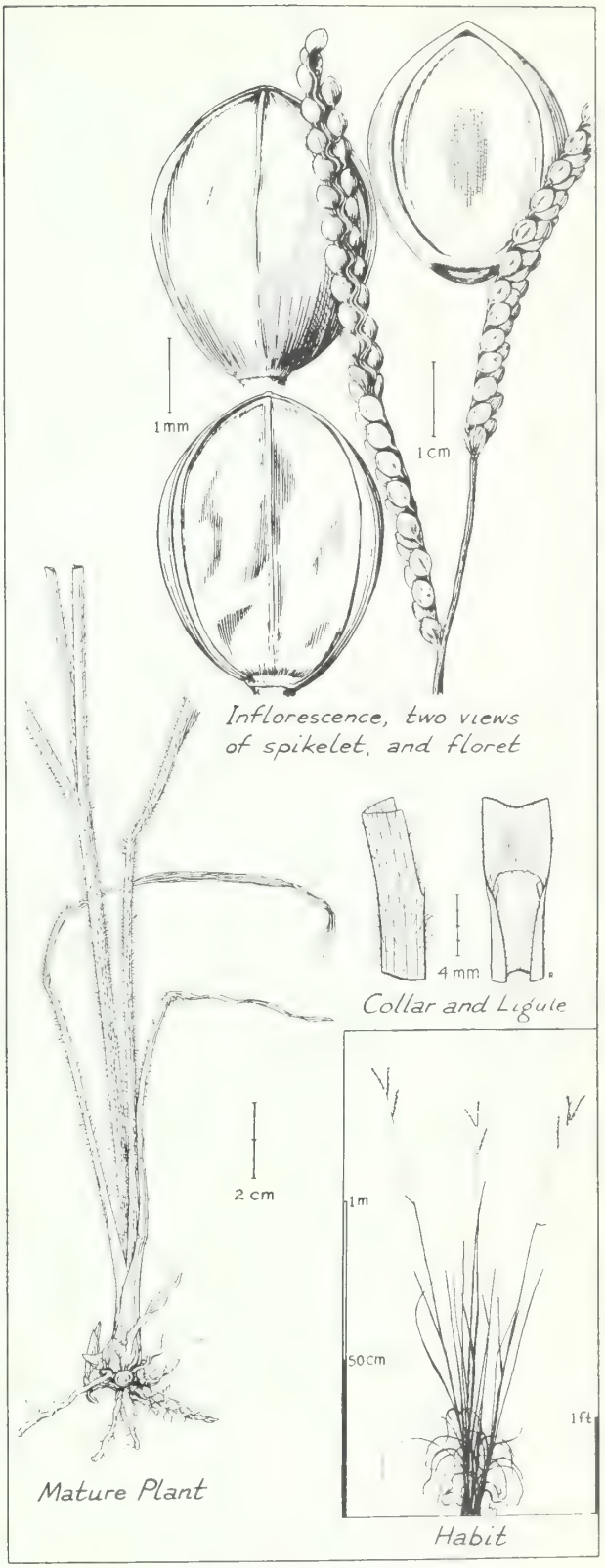
This grass thrives on disturbed sites such as firelines, road ditches, and stump holes. On undisturbed range, it prefers moist, well-drained soils, but also grows on dry, sandy sites and poorly drained flats. Under light competition, plants spread by stout, scaly rhizomes to form large, loose bunches; in dense bluestem stands clumps are small.

Florida paspalum is readily distinguishable from other paspalums on longleaf pine ranges by its robust habit, large spikelets, and long, broad leaves. Until inflorescences appear in early summer, the species may be confused with big bluestem. Thereafter, and where old seedstalks persist, Florida paspalum can be distinguished by conspicuously zigzag rachises of the shattered racemes. Vegetative differences are described under big bluestem.

The young leaves are palatable and nutritious. As plants mature, the foliage becomes tough and less palatable. The grain, which is among the largest in southern range grasses, is eaten by quail, doves, and turkey.

Range: Texas to Florida, north to Missouri and Maryland.

Perennial. **Culms** 1-2 m. tall, solitary or sparse from robust, scaly rhizomes; **sheaths** keeled, overlapping below, glabrous to villous, sometimes papillose; **ligule** a firm brown membrane 2-3 mm. long; **blades** 15-50 cm. long, 4-10 mm. wide, usually villous on the upper surface near the base, ascending, firm, flat or folded, the upper ones reduced in size; **inflorescence** of two to five racemes 4-12 cm. long; **spikelets** 4 mm. long, crowded, ovoid, pale, and glabrous, usually in pairs, on each side of a zigzag rachis, but one sometimes absent or rudimentary; **first glume** wanting; **second glume** and **sterile lemma** equal, scarcely covering the fruit at maturity; **grain** 3-3.5 mm. long, ovoid, light brown, minutely papillose, striate.



Florida paspalum

FRINGELEAF PASPALUM

Paspalum ciliatifolium Michx.

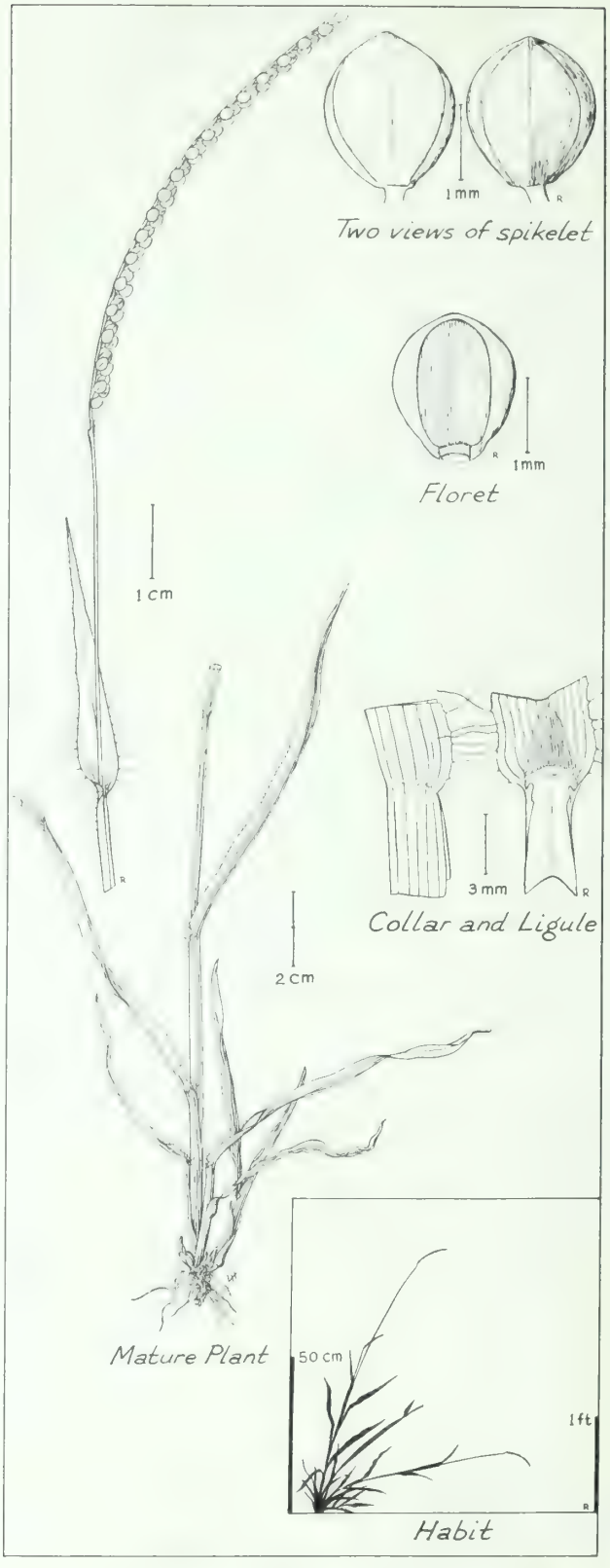
Fringeleaf paspalum is one of the smallest common paspalums on longleaf pine-bluestem ranges. The slender flower stalks occasionally exceed 2 feet, but at this length they rarely stand erect. Leaves are mostly basal, often spreading along the ground. Light green blades, usually less than 8 inches long, are often twisted. The flower stalk ends in an inflorescence of one to three slender racemes, each 1½ to 4 inches long. In addition, there are axillary inflorescences, usually enclosed or half hidden in leaf sheaths. The grain is smooth, pale, and small—1/16 inch long, or less.

Vegetatively, fringeleaf paspalum resembles crabgrass, *Digitaria* spp., and may inhabit the same site. Hairs on its leaf blades are marginal only whereas hairs of crabgrass blades, if present at all, grow from surfaces as well as margins. Through most of the growing season they can be distinguished by floral characteristics. Crabgrass has only terminal racemes—generally three or more.

Fringeleaf paspalum grows almost exclusively on heavily grazed, or otherwise disturbed, sandy sites. It is nowhere abundant and hence not an important forage producer, even though palatable.

Range: Texas to Florida, north to Minnesota and New Jersey.

Perennial. **Culms** 20-90 cm. tall, erect or spreading from a knotted base, lower parts brown or purplish; **sheaths** keeled, glabrous, or the lower ones puberulent, glabrous, or ciliate along the overlapping margins; **ligule** membranous, short, backed by a ligular beard 1-3 mm. long; **blades** ascending or spreading, 10-35 cm. long, 7-12 mm. or rarely 20 mm. wide, usually strongly ciliate to ciliate-papillose along the undulate margin, otherwise glabrous, flat, acuminate at the apex, rounded to subcordate at the base; **inflorescence** of one to three racemes, each 5-10 cm. long; **spikelets** 2 mm. long, suborbicular; **first glume** wanting; **second glume** slightly shorter than the **sterile lemma**, exposing the fruit at maturity, second glume and sterile lemma both three-nerved, the former glabrous to minutely pubescent with obscurely capitate hairs, sometimes minutely and dimly speckled; **grain** about the size and shape of the spikelet, pale yellow, smooth, and shining.



Fringeleaf paspalum

MISCELLANEOUS GRASSES

Although the bluestems, panicums, and paspalums account for most grass forage of longleaf pine-bluestem range, many other grass genera are represented, often by a single species. Few are important forage plants. Some are grazed only when other forage is unavailable; others, though readily eaten by cattle, either are widely scattered individuals or grow abundantly only on certain sites.

GIANT CANE

Arundinaria gigantea (Walt.) Muhl.

Giant cane is the largest native grass in the United States. On fertile bottom-land sites, it reaches 25 feet in height and has stems up to ¾ inch in diameter. Scattered small plants may be found on uplands adjacent to bottoms. Unlike most other grasses, it is an evergreen shrub, the stems functioning for several years.

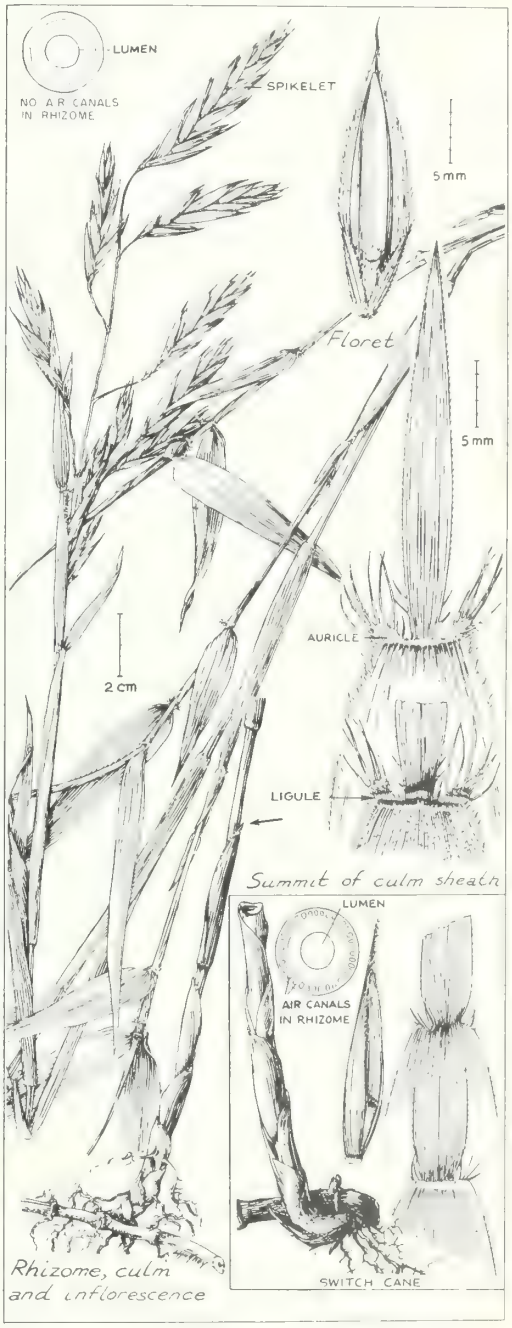
It is one of two bamboos indigenous to this country, switchcane, *A. tecta* (Walt.) Muhl., being the other. Both are easily distinguishable from other grasses by stout, hollow, jointed stems familiar in cane fishing poles. Their leaf blades are drastically narrowed at the base, while in typical grasses, blades are wide at this point. Both bamboos grow in the South, but only giant cane is likely to occur on longleaf pine-bluestem ranges west of the Mississippi River. Switchcane inhabits Coastal Plain soils from Mississippi to Maryland. Neither species flowers often enough to be identified by usual taxonomic procedures. Under low magnification, however, switchcane is seen to have well-developed peripheral air canals in its rhizomes, and giant cane lacks this feature (McClure 1963).

Giant cane is excellent forage. Cattle graze leaves and twigs intensely during winter when other green herbage is scarce. Forage value may be inferred from that of switchcane. On an experimental range in North Carolina, switchcane was grazed from May to January and furnished 70 to 93 percent of the cattle diet. Crude protein, calcium, and phosphorus averaged higher than in other species studied and well above the requirements of growing cattle. Under careful management, grazing capacity was high—½ to 1 acre per cow-month.

Despite its high value, giant cane is important on few ranges. Although extensive canebrakes were once common along many streams, most have been seriously depleted by overuse. Burning to reduce height, followed by heavily concentrated grazing, eliminated many stands. Large brakes can be very productive if judiciously managed. Where giant cane furnishes a minor part of the forage, it is usually utilized excessively.

Range: Southern and Southeastern States from Texas and Oklahoma eastward to West Virginia and Florida.

Perennial. **Culms** 1-8 m. tall, erect, smooth and hard, to 2 cm. thick, arising abruptly from a stout rhizome devoid of air canals; **lower culm sheaths** about half as long as the internode, withering and soon falling; **upper culm sheaths** with 10-12 bristles 6-9 mm. long at the summit, sometimes growing out of a definite pair of auricles, a dense band of stiff hairs across the collar; **ligule** firm, scarcely 1 mm. long; **leaf blades** petiolate, rounded at the base, acuminate at the tip, glabrous to pubescent, 15-27 cm. long, 2.5-4 cm. wide on the main culm and primary branches, shorter and narrower on the ultimate branchlets, often in dense, flabellate clusters; **inflorescences** paniculate or racemose, crowded toward the ends of leafy or leafless twigs with few to several spikelets on slender, angled pedicels 2-30 cm. long, hirsute to nearly glabrous; **spikelets** 4-7 cm. long, about 8 mm. wide, mostly with 8-12 flowers, rather loose; **glumes** distant, acuminate, pubescent, the lower sometimes wanting; **florets** 1.5-2 cm. long, the keeled, broadly lanceolate lemma tapering to an awn about 4 mm. long.



Giant cane

COMMON CARPETGRASS

Axonopus affinis Chase

Carpetgrass differs markedly in growth habit from most southern range grasses. Under favorable conditions it spreads rapidly by stolons, developing a dense sod. The best carpetgrass site is a moist, medium- to fine-textured soil where grazing is intense. On dry, sandy soils it occurs sparingly, growing in shallow depressions or as small, widely scattered colonies along animal trails and on intensely grazed areas.

Where use is light, carpetgrass cannot compete successfully with taller grasses. On a Louisiana range that had been grazed heavily for 12 years, it comprised 15 percent of the vegetation. During 3 years after grazing was discontinued, it declined to 3 percent.

Slender flower stalks up to 2 feet tall are produced throughout the growing season. The inflorescence consists of two to four slender racemes 1 to 3 inches long. Leaf blades are mostly 4 to 6 inches long and about ¼ inch wide, with bluntly rounded tips.

Vegetatively, carpetgrass resembles St. Augustine grass, *Stenotaphrum secundatum* (Walt.) Kuntze, and centipedegrass, *Eremochloa ophiuroides* (Munro) Hack. Its inflorescence consists of several racemes, however, while that of the other grasses is a solitary spike.

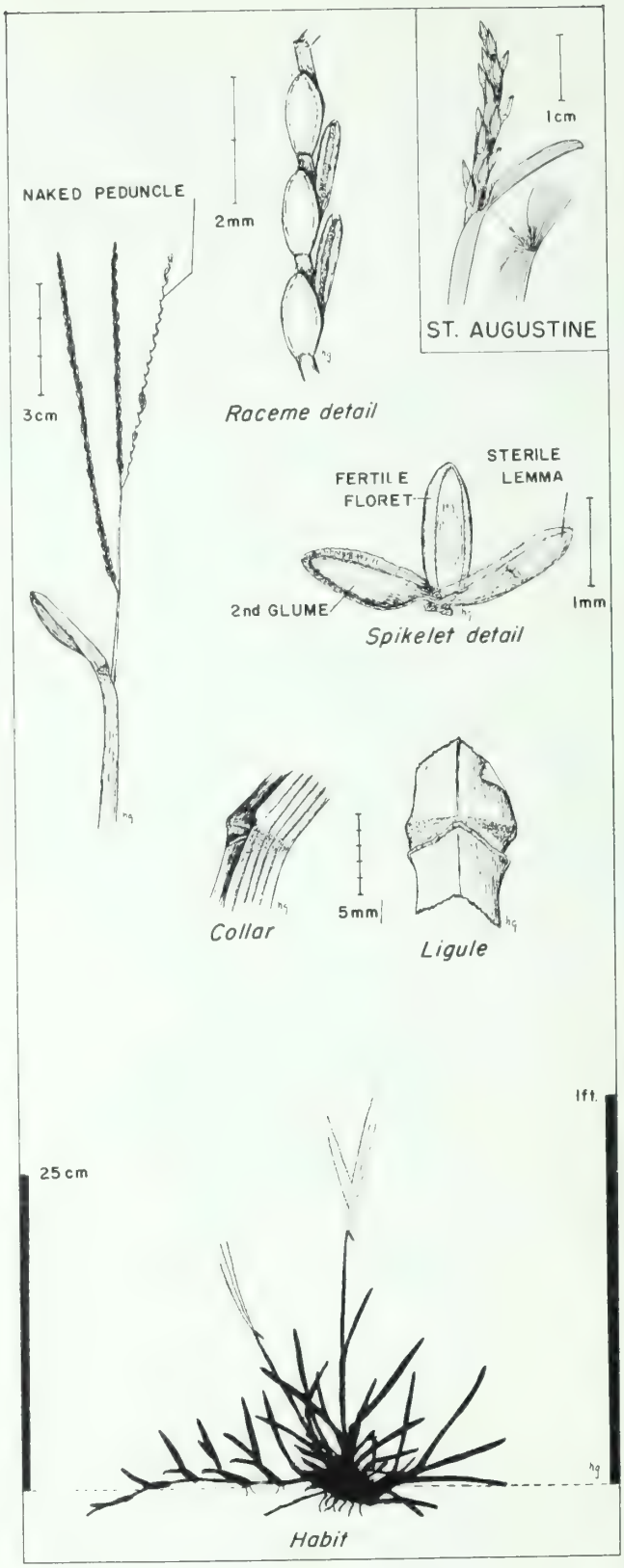
Big carpetgrass, *A. furcatus* (Flügge) Hitchc., and tropical carpetgrass, *A. compressus* (Swartz) Beauv., also grow on southern pine forest ranges. Their characteristics and forage values are similar to those of common carpetgrass.

Common carpetgrass is nutritious and highly palatable throughout the growing season. Although cattle usually prefer it over most of the associated grasses, it is too sparse on well-managed ranges to contribute much forage. Grazing intensely enough to maintain carpetgrass stands adversely affects soil conditions and pine regeneration; it also leaves little forage for winter use.

Carpetgrass is valuable mainly as cover on range areas grazed too heavily to support other perennial grasses. It is also useful for seeding grazed firebreaks, for it readily withstands the utilization pressure necessary to minimize fuel.

Range: Coastal Plain from North Carolina to Texas, north to Oklahoma and Arkansas.

Perennial. **Culms** slender, glabrous, 25-60 cm. tall in erect tufts or from stolons; **sheaths** broad, compressed-keeled, glabrous; **ligule** membranous, less than 0.5 mm. long, margin fringed; **blades** 2-6 mm. wide, flat or folded, usually short in relation to the long sheaths, conspicuously rounded at the tip; **racemes** two to four, subdigitate, 2-10 cm. long; **spikelets** 2 mm. long, oblong-elliptic, blunt at the tip, sparsely silky-pilose.



Common carpetgrass

PINEYWOODS DROPSEED

Sporobolus junceus (Michx.) Kunth

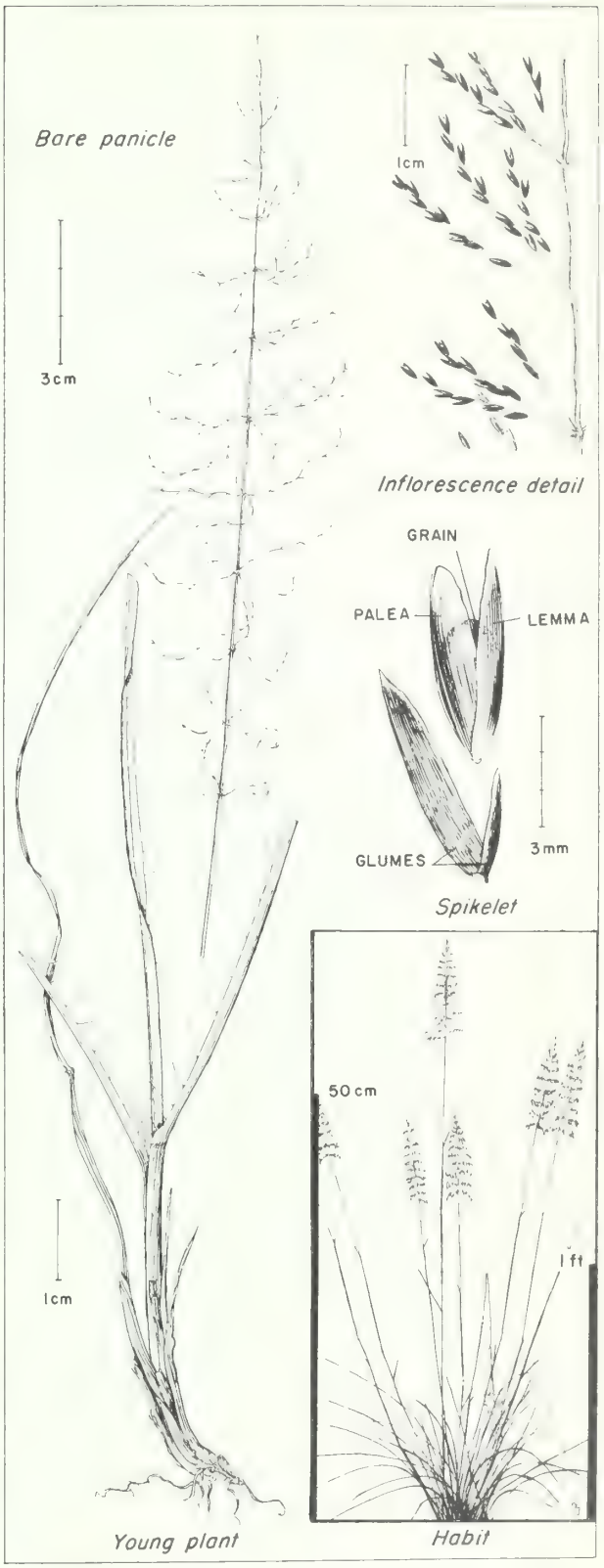
Pineywoods dropseed is a bunchgrass, with basal tufts arising from short, scaly rhizomes. In light, herbaceous cover it may form large, dense clumps. Where grass is dense, bunches are usually small, often consisting of only a few slender tufts. Foilage is mostly basal. Leaf blades are long, slender, blue green, and practically hairless. They often fold lengthwise, becoming almost tubelike in cross section. Thus, the leaves may superficially resemble longleaf pine needles. Flower stalks are 1 to 2 feet tall. They end in distinctive yellow- to brown-bronze, narrowly conical panicles that are usually 4 to 6 inches long and about 1/3 as wide.

Until inflorescences appear, pineywoods dropseed resembles cutover muhly. The latter is distinguishable by its prominent, white, pointed ligule, and by fragments of old basal foliage, which persist as a tangled mat of straw-colored fibers. The ligule in pineywoods dropseed is barely visible, and fibers of basal sheaths are nonpersistent.

Pineywoods dropseed rates fair as a forage grass. Its leaves become tough by midseason; thus, palatability is low during summer and fall. Herbage often remains green well into the winter. Although nutritive content is low during winter, cattle are attracted by the green color, and they may eat large amounts. On a Louisiana range where this species was only 1 percent of the ground cover, it provided 3 to 5 percent of the yearly diet. In January and February, it supplied about 10 percent of the grazing.

Range: Coastal Plain; Texas to Florida and Virginia.

Perennial. **Culms** 30-60 cm. tall, erect, rigid, slender, in small clumps, leafy at the base, naked above, from short, scaly rhizomes; **sheaths** glabrous, strongly overlapping; **ligule** a smooth or ciliated short membrane; **blades** 2-4 mm. wide, 2-25 cm. long, folded or involute with a thickened, pointed apex, glabrous, base of lower blades with setaceous margins, the upper blades short and far below the panicle; **panicle** 2-5 cm. wide, 10-20 cm. long, lanceolate, with several sets of verticillate, spreading branches spaced at regular intervals; **spikelets** 2.5-3.5 mm. long, acute, lanceolate, green, purple to bronze in color; **glumes** of unequal length; **lemma** and **palea** thin, free from the grain; **grain** ovoid, brown, 1.8 mm. long.



Pineywoods dropseed

YELLOW INDIANGRASS

Sorghastrum nutans (L.) Nash

Although yellow indiangrass is best known as a component of tall grass prairies, it occurs throughout the southern pine region. Plants are among the tallest grasses found on the range. Seedstalks average 4 to 5 feet but occasionally reach 8 feet. Foliage is mainly basal, with leaves up to 18 inches long and ½ inch wide. Plants spread by short, scaly rhizomes, often forming large clumps.

This grass produces large plumelike panicles, varying from bright yellow bronze to dark brown bronze. Panicles shatter quickly upon maturing; the plants remain showy only briefly, usually from late September to early October.

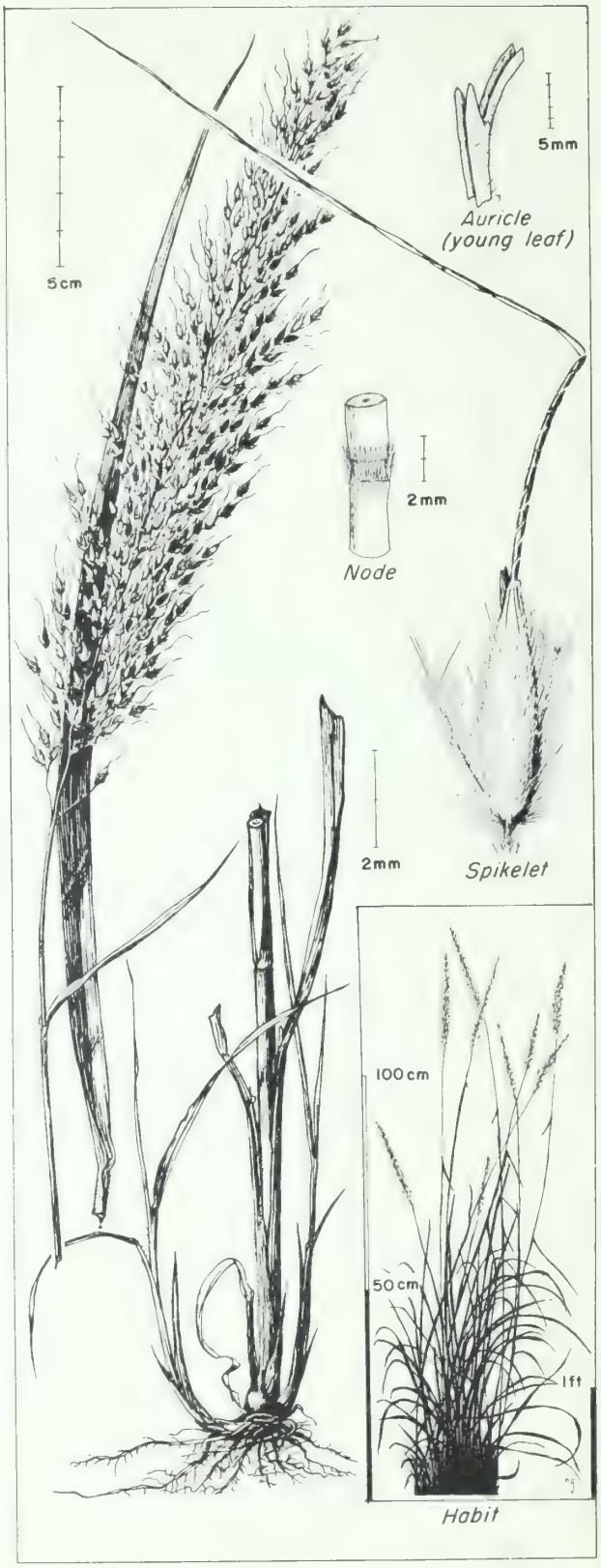
In the absence of panicles, yellow indiangrass superficially resembles switchgrass, big bluestem, and other robust grasses. Yellow indiangrass is distinguishable by its conspicuous, straight, stiff auricles and bristly nodes.

Two other *Sorghastrum* species growing on longleaf pine-bluestem range also closely resemble yellow indiangrass. Lopside indiangrass, *S. secundum* (Ell.) Nash, is common on sandhills of west Florida and south Georgia, and in sandy pinelands of Alabama. As the name implies, its panicles, in contrast to the relatively symmetrical ones of yellow indiangrass, are decidedly one sided. Slender indiangrass, *S. elliottii* (Mohr) Nash, grows throughout the South, mainly on sandy sites. Its flower stalks, in contrast to the relatively stiff ones of yellow indiangrass, are weak and nodding. Lopside and slender indiangrass lack rhizomes; both have twice-bent awns about 1 inch long, while awns of yellow indiangrass are bent once and are ½ to ¾ inch long.

Yellow indiangrass is an excellent forage plant. Because it is highly palatable and scarce on most ranges, it is usually overgrazed, even under moderate use. On heavily grazed ranges, it is confined to brushy areas that cattle cannot readily penetrate. Managing for a high yield of this grass therefore appears impractical.

Range: Eastern United States, west to Arizona, Utah, Wyoming, and North Dakota.

Perennial. **Culms** glabrous with setaceous nodes, 1-2.5 m. tall, in loose tufts from scaly rhizomes; **sheaths** glabrous or papillose-pubescent, often hairy in the throat; **ligule** 2-4 mm. long, thick, stiff, conspicuous, between straight, stiff auricles; **blades** 5-10 mm. wide, sometimes glaucous, scabrous, elongate; **panicle** narrow, exserted, nodding at the apex, bronze to golden brown and shining, branches villous, shattering early; **sessile spikelet** fertile, 6-8 mm. long, hirsute, the awn once-geniculate, 1-1.5 cm. long; **pedicellate spikelet** wanting, the villous pedicel 1/2 to 1/3 the length of the fertile spikelet.



Yellow indiangrass

CAROLINA JOINTTAIL

Manisuris cylindrica (Michx.) Kuntze

Carolina jointtail grows on sandy soils throughout the longleaf pine-bluestem type. In spring and early summer, plants are easily identified by the jointed, cylindrical, spikelike raceme at the tip of each flower stalk. Racemes are generally 3 to 6 inches long and about 1/8 inch in diameter. They shatter readily at maturity; plants may afterwards be recognized by the swollen joint at the stalk tip.

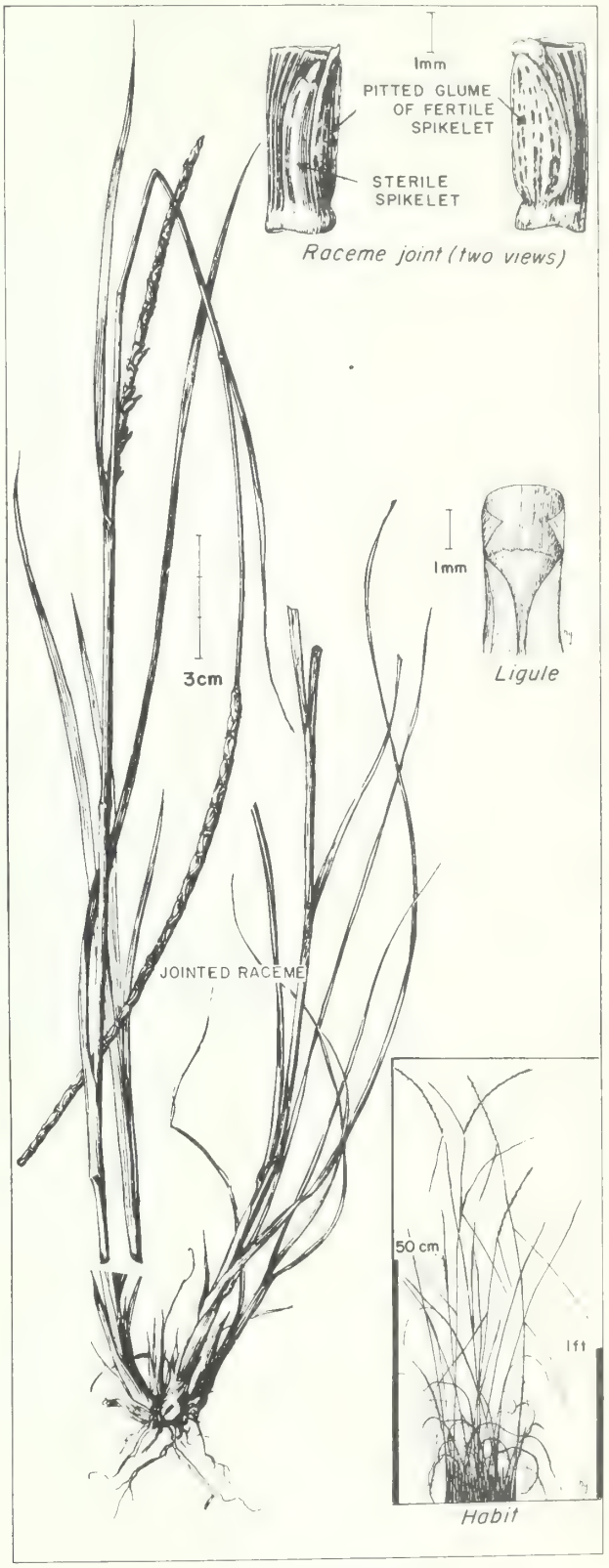
Carolina jointtail usually grows in small colonies. Since the seed-bearing joints of the racemes are heavy, most seeds remain near the parent. New plants begin as small tufts, spreading by short rhizomes. Height at maturity is about 3 feet.

Manisurus tessellata (Steud.) Scribn., and *M. rugosa* (Nutt.) Kuntze, also grow on longleaf pine-bluestem ranges. Both have flattened leaf sheaths; those of Carolina jointtail are round.

Carolina jointtail is palatable and nutritious. Apparently it is intolerant of close use, as plants are rarely found on heavily grazed ranges.

Range: Texas to Florida, north to North Carolina and Missouri.

Perennial. **Culms** 30-100 cm. tall, broad at the base, in tufts from short, stout rhizomes, erect, slender, generally unbranched; **sheaths** 2-3 mm. wide, shorter than the internodes, cylindrical, sometimes reddish or purplish; **ligule** a short membrane; **collar** and **nodes** purple; **blades** 1-3 mm. wide, to 30 cm. long, slightly curved, flat or involute; **racemes** 10-20 cm. long, cylindrical, purple, solitary on main culm and branches; **spikelets** awnless, in pairs at the nodes of a thickened rachis; **sessile spikelet** 4-5 mm. long, perfect; **pedicellate spikelet** rudimentary, reduced to two scales; **first glume** pitted along the nerves.



Carolina jointtail

PURPLE LOVEGRASS

Eragrostis spectabilis (Pursh) Steud.

With its large colorful inflorescence fully expanded, purple lovegrass is among the showiest southern grasses. Until the panicles emerge in late summer, however, the plants are relatively inconspicuous. This grass grows mainly in waste areas and on ranges that have been grazed heavily or burned frequently. It thrives on sandy soil.

Mature plants are 1 to 2 feet tall, with the panicle usually 2/3 of the height and about as broad as long. At maturity, panicles break away from the stalk to become "tumbleweeds." Leaf blades are 6 to 12 inches long and 1/8 to 3/8 inch wide, tapering to a fine point.

Coastal lovegrass, *E. refracta* (Muhl.) Scribn., and Elliott lovegrass, *E. elliottii* S. Wats., resemble purple lovegrass in size and growth habit. Their panicles are green to dark gray with delicate branches, whereas panicles in purple lovegrass are bright purple with comparatively rigid branches.

In the spring, purple lovegrass foliage is palatable and nutritious. With emergence of the inflorescence in late summer, palatability declines rapidly. Plants are rarely abundant enough to supply significant amounts of herbage.

Range: Arizona to Minnesota, east to Maine and Florida.

Perennial. **Culms** 30-60 cm. tall, in tufts from a knotty, rhizomatous base; **sheaths** longer than the internodes, overlapping, glabrous to pilose, conspicuously long-pilose at the summit; **ligule** a short, ciliate membrane 0.2 mm. long, backed by a ring of silky hairs 2-4 mm. long; **blades** 3-8 mm. wide, to 30 cm. long, taper-pointed, stiff, flat, scabrous above, smooth beneath, ascending, glabrous to pilose; **panicle** 15-45 cm. long, ovoid, about 2/3 the entire height of the plant, branches minutely scabrous, strongly pilose in the axils; **spikelets** 4-8 mm. long, 2 mm. wide, on long pedicels, 5-12-flowered, purple; **florets** 1.6 mm. long, keels of the palea short-ciliate and bowed out; **grain** 0.6-0.8 mm. long, brown.

Purple lovegrass

CUTOVER MUHLY

Muhlenbergia expansa (DC.) Trin.

Cutover muhly grows throughout the lower Coastal Plain in swales and on moist flatwoods. Although the name implies that it occupies only cutover lands, it is sometimes abundant under pine stands. On unburned ranges, the long, stiff, slender leaves are in large, tightly tufted bunches, with blades near the perimeter of the bunch reclining and those near the center standing erect. The plants resemble longleaf pines that have not started height growth.

Flower stalks, 2 to 3 feet tall, are slender and weak, often reclining at maturity. Panicles are purplish, conical, and usually about 6 inches long, but occasionally reach 18 inches. Branches of the panicle are delicate, imparting a soft feel to the inflorescence.

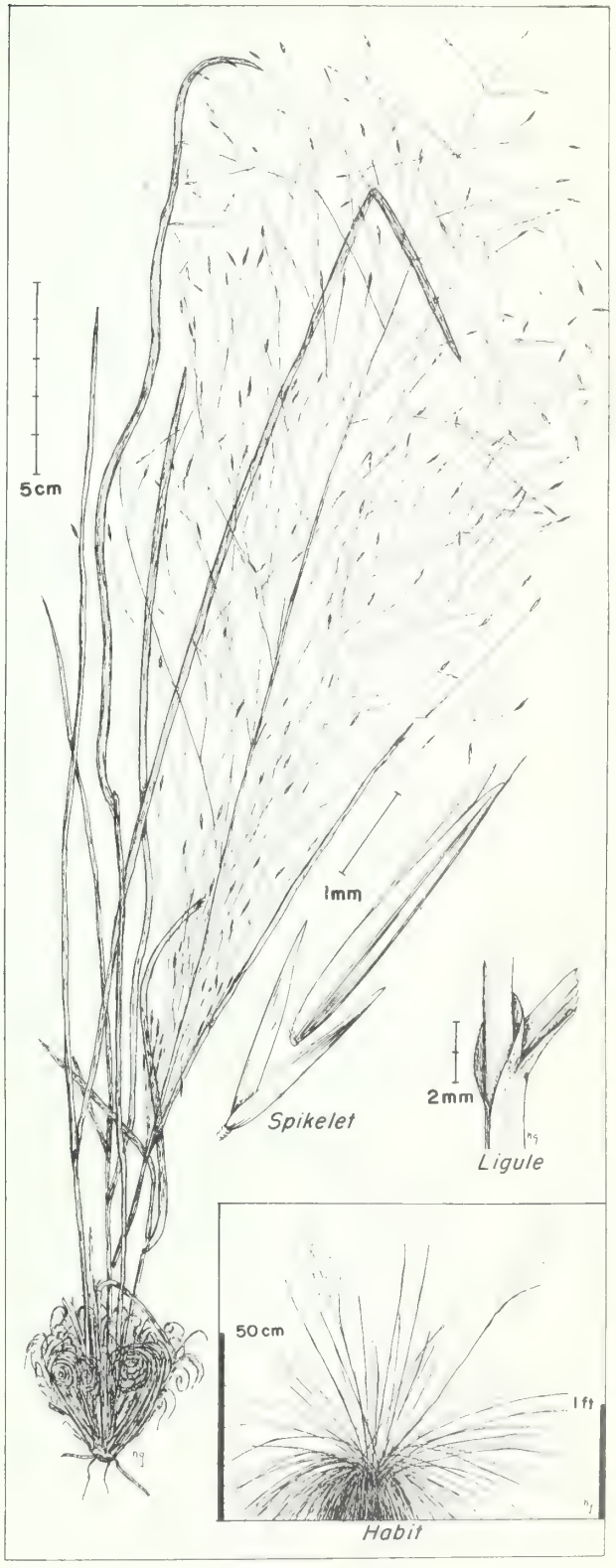
Although cutover muhly is more abundant than hairawn muhly, *Muhlenbergia capillaris* (Lam.) Trin., it is similarly distributed. Its spikelets are either awnless or have awns averaging less than 1/8 inch; spikelets of hairawn muhly bear awns ¼ to ¾ inch long. Despite similarity in panicle size and color, cutover muhly has one-flowered spikelets, as compared to the 6- to 12-flowered spikelets of purple lovegrass. Although it resembles pineywoods dropseed vegetatively, cutover muhly can be distinguished by its curly, fibrous, matlike remnants of old basal leaves. Its prominent, pointed, white ligules also help distinguish it from pineywoods dropseed, whose ligule is barely visible.

Cutover muhly is low in forage value. Cattle ordinarily eat small amounts of new leaves in the spring, but they largely reject the foliage later in the growing season. Although mature leaves are tough and fibrous, some are eaten during the winter because they often remain green. This species may impair production of better forage. On unburned, moderately grazed range, the plants attain large basal areas, and their leaves reach far beyond the root crowns. Thus, a comparatively sparse stand may dominate a site, excluding most plants of higher quality.

Because cutover muhly is generally considered a range weed, control has been studied. In Louisiana trials, a single fire failed to kill plants but reduced size of clumps. Where 30 to 40 percent of the range was burned each year in rotation, cattle concentrated on new burns in the spring. With the old growth destroyed by fire, cattle closely utilized new foliage. One cycle of burning and subsequent brief heavy use largely eliminated the species without significantly damaging the better grasses.

Range: Coastal Plain; east Texas to Florida and Virginia.

Perennial. **Culms** 60-100 cm. tall, slender, erect, in dense tufts; **sheaths** longer than the internodes, wider than the blade, loose, smooth to slightly scabrous, weathering to form a fibrous, curling mass; **ligule** 2-3 mm. long, wider than the blade, firm, pointed; **blades** 1-2.5 mm. wide, to 40 cm. long, the upper short, the lower long, flat, becoming involute; **panicles** 10-45 cm. long, pyramidal, with capillary branches; **spikelets** 3.5-5 mm. long, purple, on long, scabrous, capillary pedicels, awnless or with a short awn 2-3 mm. long.



Cutover muhly

GREEN SILKYSCALE

Anthaenantia villosa (Michx.) Beauv.

Green silkyscale is common, though seldom abundant, on longleaf pine-bluestem range. It grows mostly on sandy sites, frequently in association with Elliott bluestem and paintbrush bluestem.

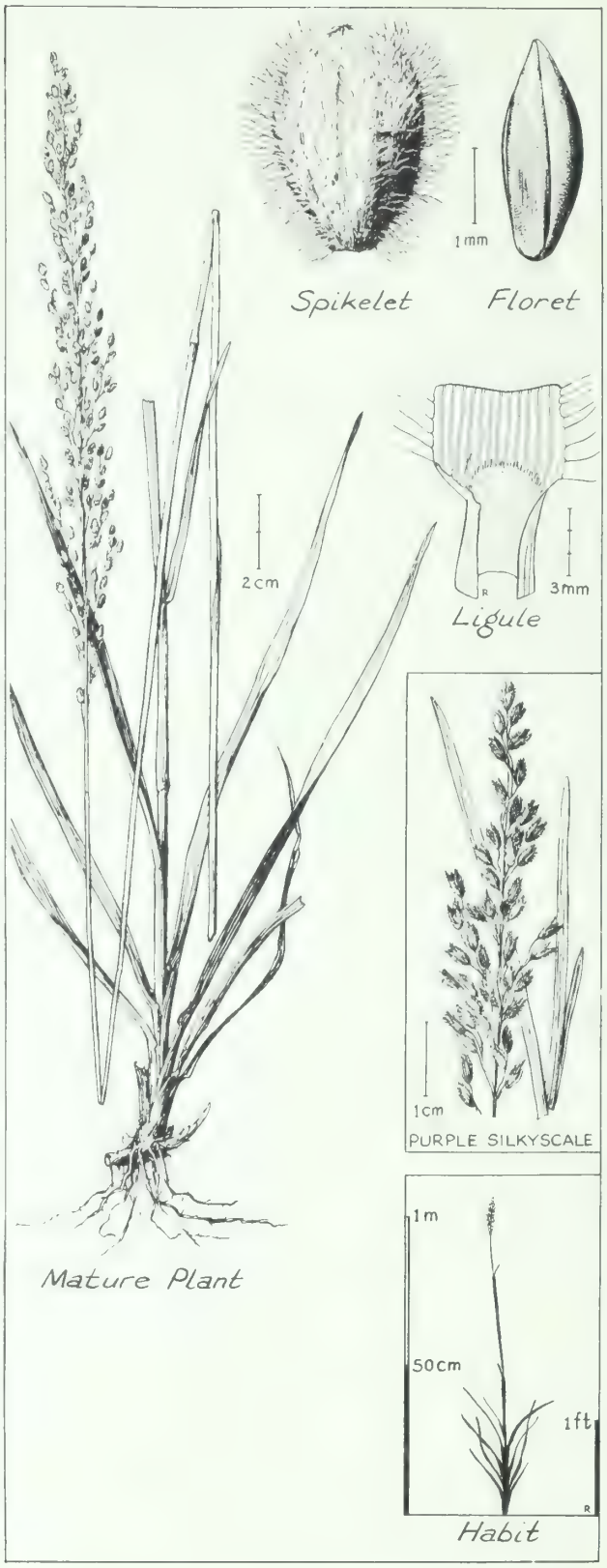
Plants spread by short rhizomes. In heavy bluestem stands, they usually form small, irregular, densely tufted clumps. Where soil is unusually fertile, plants may occasionally attain basal diameters of 10 or 12 inches. The smooth, pea-green, twisted foliage is conspicuous among other grasses. Basal leaves frequently reach 1 foot in length, but upper leaves are very short. Blades are about ¼ inch wide, tapering to a point at the tip. Mature plants are about 3 feet tall. The inflorescence is a narrow panicle up to 7 inches long. Spikelets are green, conspicuously fuzzy, about 1/8 inch long, and egg shaped.

Purple silkyscale, *A. rufa* (Ell.) Schult., also grows throughout the longleaf pine-bluestem type, usually on wetter sites than green silkyscale. At all seasons it can be distinguished from green silkyscale either by its purplish spikelets or rounded leaf blade tips.

Green silkyscale foliage is palatable and nutritious. On most ranges, grazing value is limited by scarcity.

Range: Coastal Plain, Texas to Florida and North Carolina.

Perennial. **Culms** 60-120 cm. tall, slender, in small tufts or singly from short rhizomes; **sheaths** glabrous, nonkeeled, much shorter than the internodes, crowded and overlapping at the base of the plant; **ligule** a short, ciliate membrane; **blades** 5-10 mm. wide, glabrous with ciliate margins, flat, twisted along the length one to several times, taper-pointed at the apex, the basal blades 10-30 cm. long, the upper ones much reduced; **panicle** 10-17 cm. long, pale green, long-exserted above the last reduced blade; **spikelets** 3-4 mm. long, stalked, solitary, obovoid, with rows of long hairs between the nerves on the second glume and sterile lemma, first glume wanting; **grain** 2.5 mm. long, brown, shining.



Green silkyscale

BEARDED SKELETONGRASS

Gymnopogon ambiguus (Michx.) BSP.

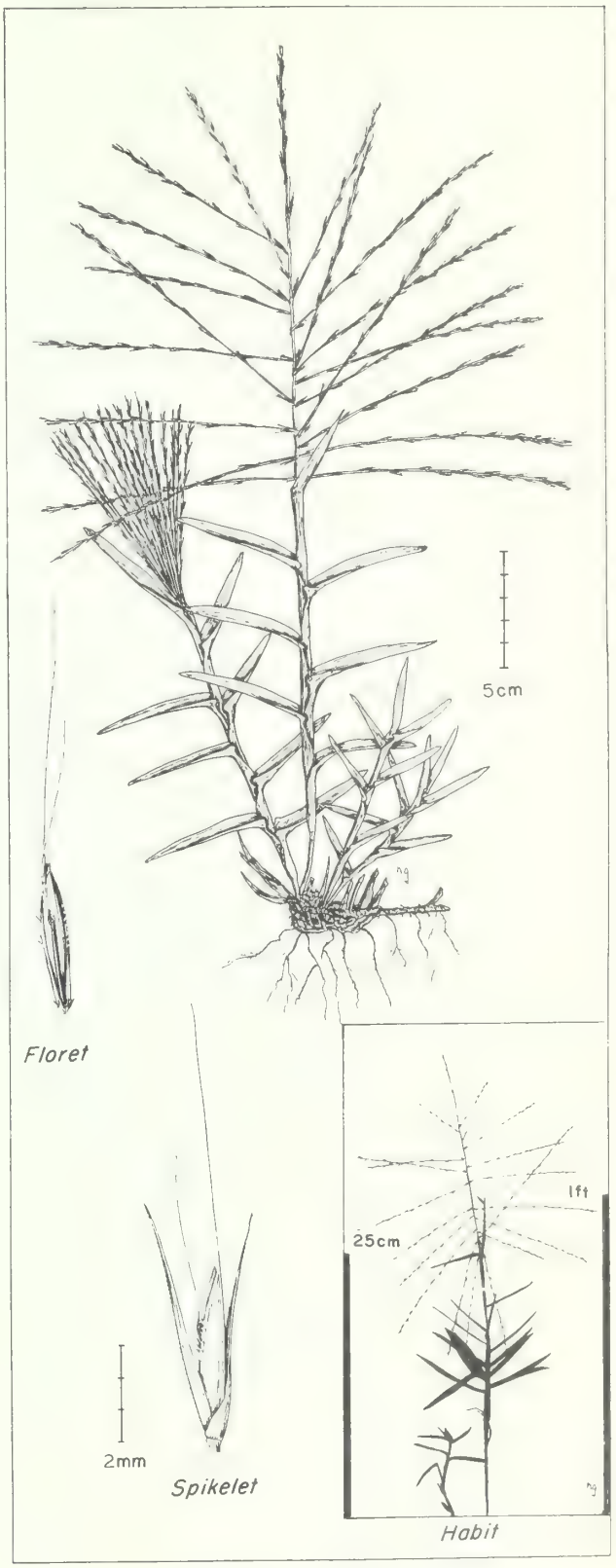
Bearded skeletongrass, though seldom abundant, is conspicuous in sandy pinelands in the South. Distinctive features include short, broad, stiff leaves and an inflorescence of many stiff, slender, divergent spikes scattered along the upper part of the flower stalk. At maturity, the seedstalk easily breaks below the lowermost spike, the entire inflorescence becoming a "tumbleweed." Plants spread by short rhizomes to form small clumps. Basal foliage is scant; leaves are mostly crowded along the rigid stalks, which are 1 to 2 feet tall at maturity.

Although slim skeletongrass, *G. brevifolius* Trin., is sometimes associated with bearded skeletongrass, it usually occupies wetter soils. It is distinguishable by its spikes, which have flowers only on the outer half; spikes of bearded skeletongrass bear flowers throughout their length.

Bearded skeletongrass rarely yields significant amounts of forage. Cattle apparently eat it, for plants are scarce on grazed range. The clumps are poorly anchored in the soil; thus cattle probably uproot many plants. Deer sometimes paw the rhizomes out of the soil in winter when better food is scarce.

Range: Texas to Florida, north to Kansas, Ohio, and New Jersey.

Perennial. **Culms** 30-60 cm. tall from short, scaly rhizomes, erect or decumbent at the base; **sheaths** crowded, overlapping with a villous ring at the summit, otherwise glabrous; **ligule** membranous; **blades** spreading, 5-15 cm. long, 5-14 mm. wide, flat, firm, cordate-lanceolate, glabrous with scabrous margins; **inflorescence** of numerous unbranched purplish spikes 10-20 cm. long; **spikelets** 4-6 mm. long excluding the 6-mm. awn, arranged the full length of the branch on two sides of a three-sided rachis.



Bearded skeletongrass

ARROWFEATHER THREEAWN

Aristida purpurascens Poir.

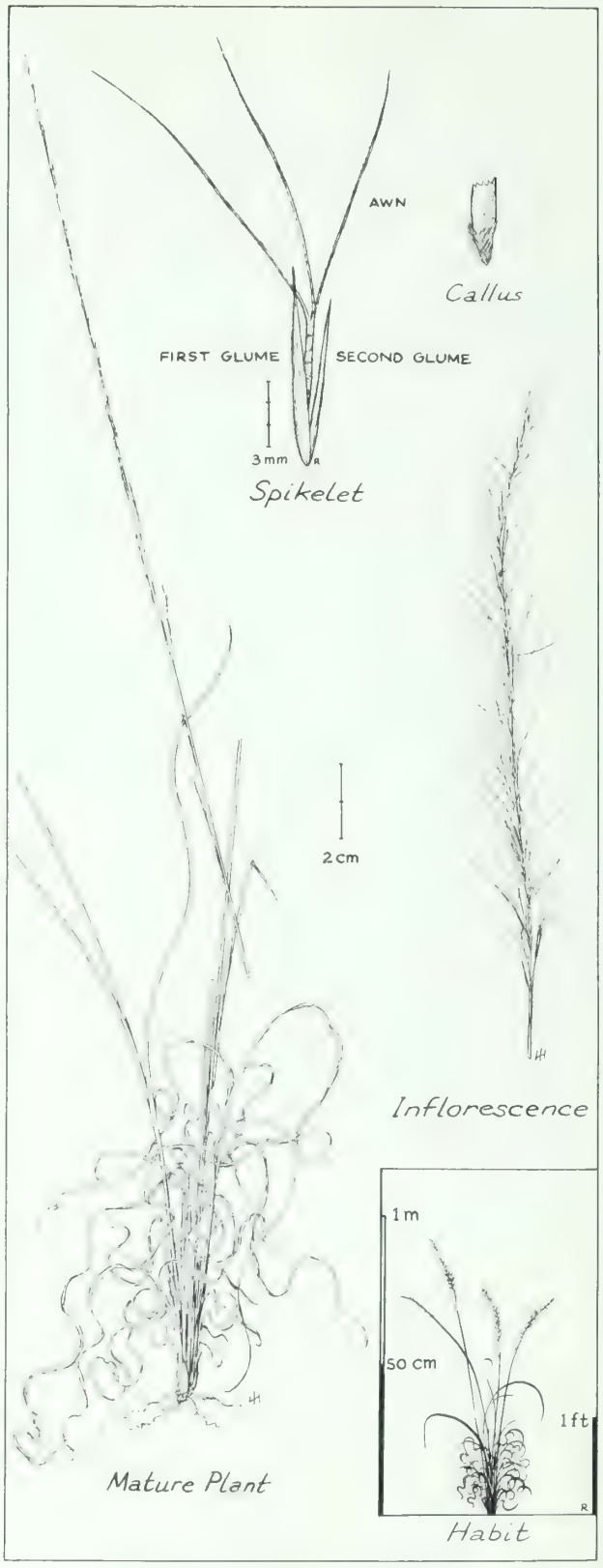
Arrowfeather threeawn is the most common *Aristida* on longleaf pine-bluestem range. It grows on dry, sandy sites, especially those heavily grazed or otherwise disturbed.

It is a perennial bunchgrass with mostly basal leaves and forms dense clumps that are usually less than 3 inches in diameter. Flower stalks, which mature in the fall, average 2 feet tall. The inflorescence is a narrow, nodding panicle 6 to 12 inches long. Spikelets are round in cross section and one-flowered. Exclusive of awns, they are about 3/8 inch long and terminate in three spreading awns, each about ¾ inch long. Although panicles may become purplish toward maturity this color is less characteristic than *purpurascens* implies. The thin, papery glumes, up to ½ inch long, persist after spikelets shatter. In the fall, foliage curls conspicuously, with many of the leaf blades forming one or more ringlets.

Arrowfeather threeawn is low in forage value. Cattle may graze it in spring, especially on freshly burned range. Palatability declines after early summer, as the foliage becomes tough and somewhat wiry.

Range: Texas to Florida, north to Wisconsin and Massachusetts.

Perennial. **Culms** 40-70 cm. tall, slender, in tufts of several stems from a weak, knotty base; **sheaths** smooth and glabrous; **ligule** a short-ciliate membrane less than 0.5 mm. long; **blades** 1-2 mm. wide, flat, to 20 cm. long, sometimes with a tuft of long hairs above the ligule, long-acuminate, in age forming complete curls or ringlets; **panicle** 15-30 cm. long, 1/3 to 1/2 the total length of the culm, the branches short, appressed; **spikelets** with three straight, spreading awns 12-25 mm. long, the center one sometimes slightly exceeding the others in length; **glumes** 6-12 mm. long, the first longer than the second, scabrous; **lemma** 6-8 mm. long, hispid, sometimes marked with six to eight diagonal dark-purple bands; the **callus** 0.5 mm. long, pubescent; **anthers** purple.



Arrowfeather threeawn

TOOTHACHEGRASS

Ctenium aromaticum (Walt.) Wood

Toothachegrass commonly inhabits flatwood sites in cutover areas. It is less abundant under longleaf pine overstories on sandy hill sites.

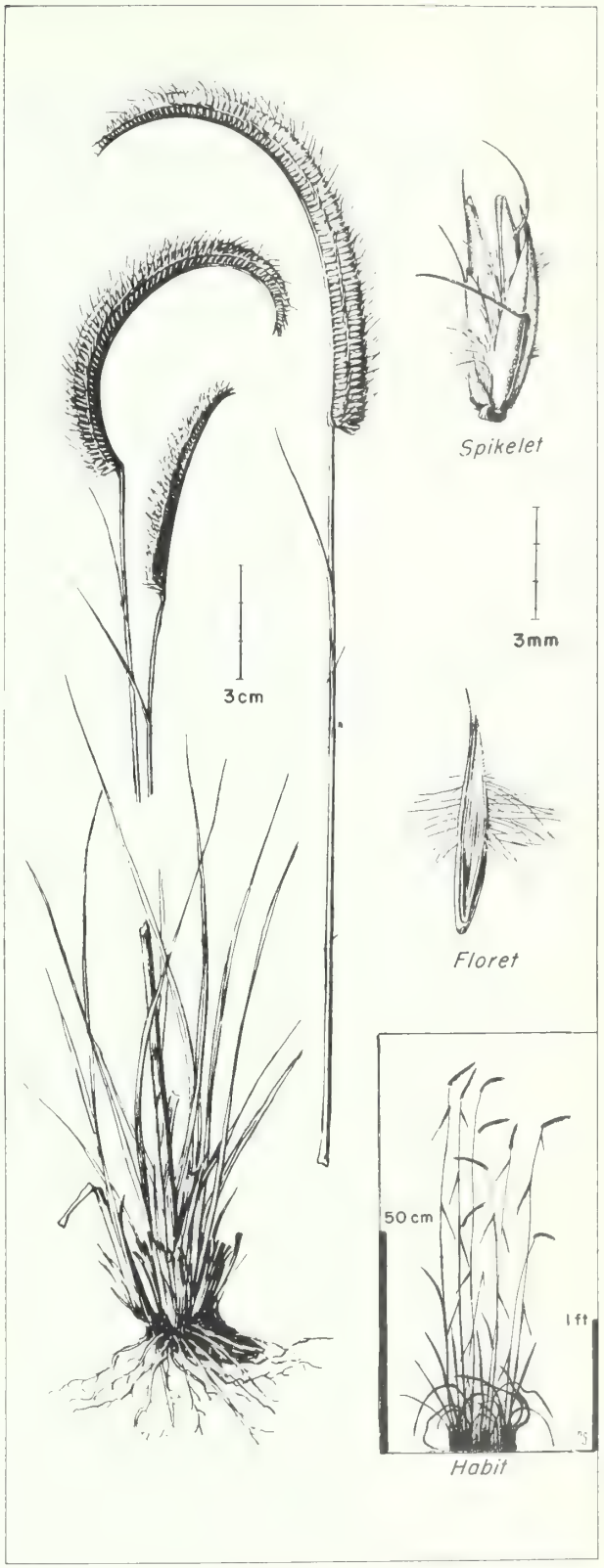
The plants are conspicuous, growing in clumps with scant foliage and many erect flower stalks 3 to 5 feet tall. Each stalk ends in a solitary, thick, usually curving, comblike spike 2 to 6 inches long. Spikelets, crowded on one side of the axis, bear a straight awn about ¼ inch long. Except for *Ctenium floridanum* (Hitchc.) Hitchc., which is restricted to Florida, no southern grass has an inflorescence resembling that of toothachegrass.

Vegetatively, toothachegrass is distinguishable from other grasses by the fibrous mat that remains after old leaf sheaths disintegrate. Although it resembles cutover muhly in this character, its fibers are straight to gently curving, not curly as in cutover muhly. Its leaf blades are up to ¼ inch wide; those of cutover muhly are less than ⅛ inch wide. Freshly dug roots emit a distinctive spicy odor; the substance responsible is reputedly effective in relieving toothache. Chewing the roots produces a slight numbness in the tongue and gums.

On unburned range, the persistent old leaves and flower stalks make toothachegrass relatively unpalatable. After a fire, cattle readily graze the herbage.

Range: Coastal Plain; Louisiana to Florida and Virginia.

Perennial. **Culms** stout, unbranched, 1-1.5 m. tall, from aromatic roots; **sheaths** shorter than the internodes, ribbed, glabrous, persistent, the old ones forming a conspicuous fibrous mass at the base; **ligule** 1 mm. long, membranous, truncate; **blades** 2-6 mm. wide, flat or involute, elongate with attenuate tips; **inflorescence** a straight or curved, thick, solitary raceme 5-15 cm. long; **spikelets** 5-7 mm. long arranged as the teeth of a comb on one side of the pubescent rachis.



Toothachegrass

PINEBARREN TRIDENS

Tridens ambiguus (Ell.) Schult.

Pinebarren tridens grows on moist flatwoods sites, particularly where moderate to heavy grazing prevents accumulation of heavy rough. It is commonly associated with slender bluestem, both on cutover lands and under open pine canopies.

Leaves are mostly basal, usually growing in one or two small tufts per plant. They are generally pale green, but the upper surface is sometimes gray green. Blades are about ⅛ inch wide and up to 12 inches long. Except for conspicuously hairy leaf collars, the foliage is hairless. Flower stalks 2 to 3 feet tall support open panicles that bear small, orange-tan to purplish spikelets. Panicle branches characteristically point upward at an angle of less than 45° from the main axis. Spikelets measure 1/6 to ¼ inch long, each with four to seven flowers. Spikelets are round in cross section when immature but become flattened with age.

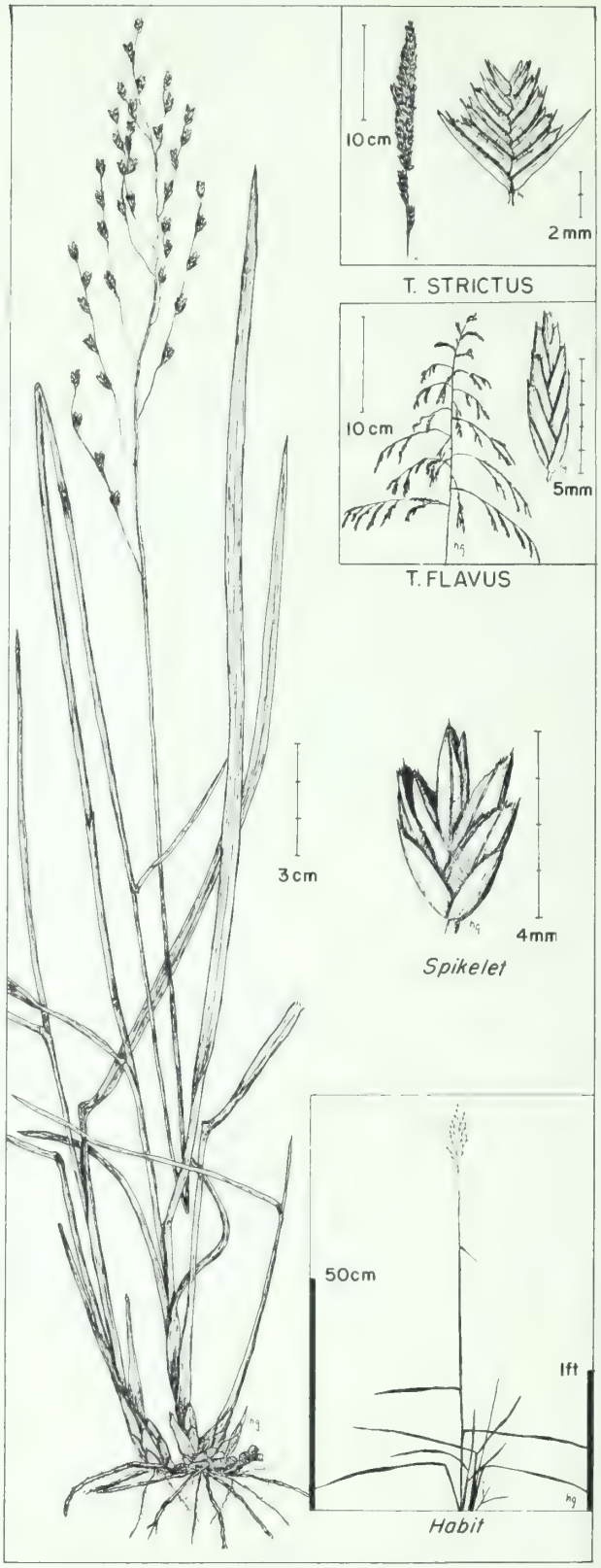
Although it may be taken for a lovegrass *(Eragrostis* sp.) because of its several-flowered, flattened spikelets, pinebarren tridens and other species of the genus *Tridens* are characterized by three hairy nerves that project beyond the tips of lemmas.

Several species of *Tridens* grow on southern pine ranges. Purpletop, *T. flavus* (L.) Hitchc., is a robust perennial occupying old fields and timbered sites. It is distinguishable by its large panicles with drooping branches and dark purple spikelets. Longspike tridens, *T. strictus* (Nutt.) Nash, inhabits wet sites. Its dense, spikelike panicle differs distinctly from the open inflorescence of other common tridens grasses. Carolina tridens, *T. carolinianus* (Steud.) Henr., and Chapman tridens, *T. chapmanii* (Small) Chase, grow on dry, sandy soils. In both, mature spikelets are rounded in cross section and ¼ inch or more long.

Young foliage of pinebarren tridens is grazed in the spring and early summer. Because plants are widely scattered and foliage is sparse, this species contributes little to the yearly diet of cattle. After the panicles emerge, plants are grazed sparingly, if at all. The spikelets emit a distinctive pungent odor that may account for the low palatability of mature plants.

Range: Coastal Plain, Texas to Florida and South Carolina.

Perennial. **Culms** 60-100 cm. tall, from a knotted base, slender, erect; **sheath** flattened, shorter than the internodes, glabrous; **ligule** a conspicuous ring of hairs; **blades** pointed, flat or slightly involute, the upper short, the lower long, but none exceeding the extended panicle; **inflorescence** a loose, tan or purplish panicle 8-20 cm. long with ascending branches; **spikelets** 4-6 mm. long, 3-4 mm. wide, four to seven-flowered, flattened; **florets** conspicuously pilose on the lower half, the three prominent veins of the lemma forming short teeth at the apex; **palea** with a conspicuously bowed keel.



Pinebarren tridens

GRASSLIKE PLANTS

Because they superficially resemble grasses, members of the sedge family (Cyperaceae) and rush family (Juncaceae) are known as grasslike plants. Both are common on longleaf pine-bluestem ranges. On most sites, they are a minor part of the vegetation, but several species grow abundantly on poorly drained soils.

The sedges most closely resemble grasses, both families belonging to the order Graminales. Their flowers are in spikelets and lack regular sepals and petals, each flower being subtended by bracts or scales. In most sedges, the stems are solid and triangular in cross section, with leaves three-ranked; grass stems are more or less cylindrical and leaves are in two ranks. Sheaths of sedge leaves are closed tubes that encase the stem. In all but a few grasses, sheaths are open. A minor technical difference distinguishes the one-seeded sedge fruit, an achene, from the grass fruit, a caryopsis.

Rushes are related more closely to lilies than to the grasses. Despite their morphological similarity to lily flowers, rush flowers appear grasslike, with sepals and petals that are small and chaffy or membranous. Although flowers may occur in dense heads or glomerules, each is a separate unit with three sepals, three petals, and reproductive parts. The fruit is a capsule with many seeds. Stems may be rounded or flattened and pithy or hollow. Unlike grass stems, rush stems are not jointed. Rush leaves are mostly basal and not distinctly two- or three-ranked, as in grasses and sedges.

Grasslike plants are important in the cattle diet only on wet sites. Forage value is generally inferior to that of grasses. Cattle graze both rushes and sedges in spring and early summer, but usually avoid them in late summer and fall. Since the plants often remain green well into the winter, cattle may again seek them after frost kills back other herbage.

GREEN FLATSEDGE

Cyperus virens Michx.

Green flatsedge often grows in small colonies on wet sites and in small low areas on otherwise well-drained soils. Plants spread vigorously from long, thick rhizomes, normally reaching about 2 feet in height but sometimes exceeding 3 feet.

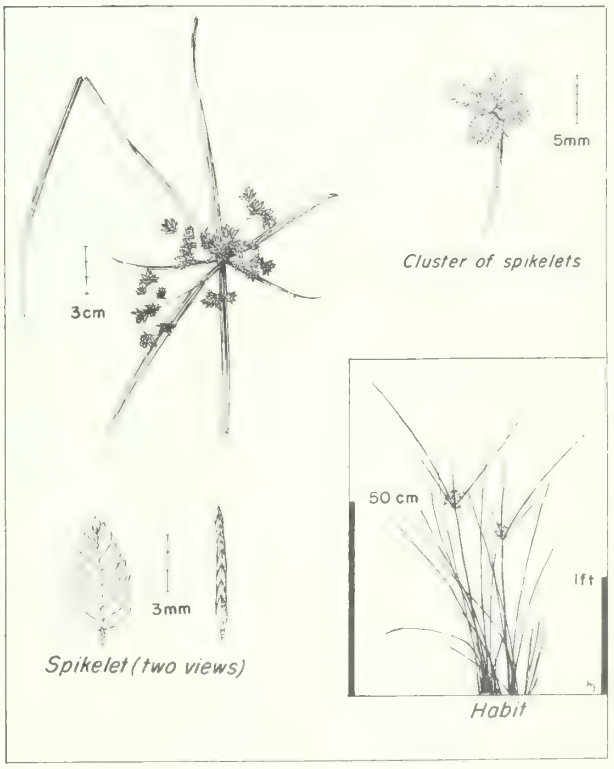
As in all *Cyperus* species, a whorl of long, leafy bracts subtends the green flatsedge inflorescence, exceeding it in height. In the immature inflorescence, flatness of the individual spikelets is obscured by the density of the clusters. As the spikelets develop, however, new flowers form at the tips, and the lower, mature flowers fall. Thus, by midsummer the inflorescence consists of loose clusters of distinctly flat spikelets borne on naked stalks. Mature spikelets are about ⅛ inch wide and less than 1/32 inch thick. Length of spikelet depends on maturity, ranging from about ¼ inch in young inflorescences to ½ inch at maturity. Each flower of the spikelet produces a straight, narrow achene about 1.5 mm. long.

Leaves are all basal. They are about ¼ inch at the base, abruptly narrowing to about ⅛ inch, then tapering gradually to a fine point. Blades ascend stiffly, reaching 2 feet or more in length. Near their bases, leaves are loosely coated with a mat of fine hairs; otherwise, plants are hairless. Small warty lumps often appear between veins of the blades, giving the leaves a knotty appearance.

Although green flatsedge is common, it is unimportant as forage. The foliage is not readily eaten by cattle and the seed apparently has little value for wildlife.

Range: Texas to Florida, north to Kansas, Missouri, Illinois, and New Jersey.

Perennial. Scapes to 75 cm. tall, forming clumps or colonies from stout rhizomes; leaves basal, ascending, elongate, usually exceeding the inflorescence; the base 4-7 mm. wide and woolly-pubescent; upper blade glabrous, 1-2 mm. wide, gradually narrowing to tip; inflorescence an umbel of spikelet clusters, subtended by involucre of leaflike bracts, peduncles or rays of umbel unequal in length; spikelets 3-4 mm. wide, up to 14 mm. long; fruit a linear achene 1 mm. long or less, developing above each scale of spikelet.



Green flatsedge

PINEHILL BEAKRUSH

Rhynchospora globularis
(Chapm.) Small var. *recognita* Gale

Pinehill beakrush is probably the most common grasslike plant on longleaf pine-bluestem range. It grows most abundantly on poorly drained flatwoods or other wet sites, but is also a common associate of bluestem grasses on drier soils. Its brown seed heads often dominate the landscape in summer before most grasses head.

Plants grow in small tufts of erect basal leaves 4 to 12 inches long and 1/16 to ⅛ inch wide. Stalks, one to several per plant, range in height from 6 inches to over 3 feet. Leaves are mainly basal, but a few reduced leaves are borne on the stalk to the base of the inflorescence. Stalks, erect when young, recline toward maturity.

The inflorescence consists of spikelet clusters on branches arising from the axils of upper leaves. Each branch divides into a compound head, with each branchlet supporting a compact cluster of spikelets. A spikelet, though with several flowers, seldom matures more than one fruit. Spikelets are rusty brown and about ⅛ inch long. The fruit, about 1/16 inch long, is a hard, oval, wrinkled achene, slightly flattened, with the remnant of the style forming a pointed cap or "beak." A whorl of bristles, somewhat shorter than the achene, arises from the achene base.

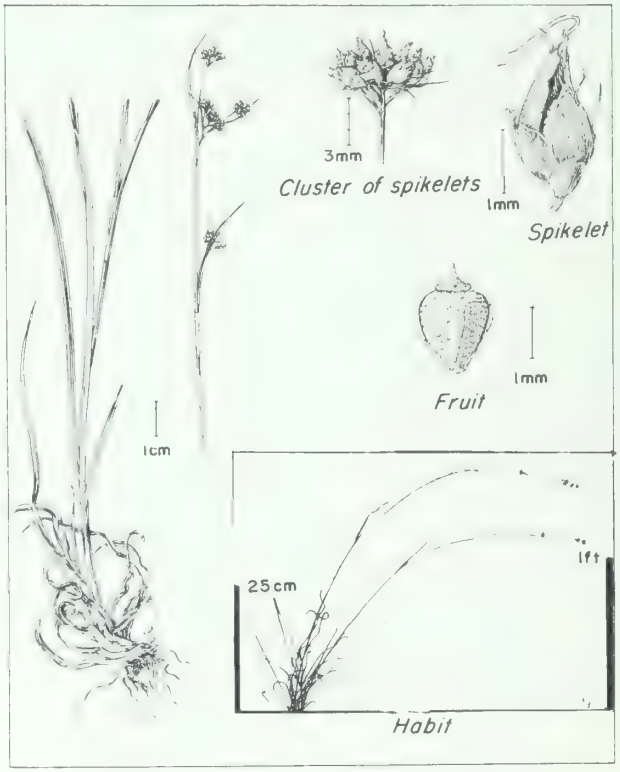
Fruit characteristics, especially beak and bristle length, separate pinehill beakrush from two somewhat similar beakrushes. N o d d i n g beakrush, *Rhynchospora glomerata* (L.) Vahl, has longer, more slender spikelets, a beak as long as the achene body, and bristles longer than the combined achene and beak. Big beakrush, *R. cephalantha* A. Gray, the most robust of the three beakrushes, has spikelets and fruits resembling those of nodding beakrush in size and shape. Its spikelets are one-flowered, however, while those of the other two have several flowers.

Typical pinehill beakrush also grows throughout the longleaf pine-bluestem type but is usually less robust and has smaller spikelets and achenes than the variety *recognita* described here.

On some sites, pinehill beakrush provides up to 3 percent of the yearly cattle diet. Beakrush seeds are considered good quail food.

Range: Coastal Plain, New Jersey to Florida and east Texas; inland to Tennessee, Missouri, and Oklahoma.

Perennial. **Culms** glabrous, to 1 m. tall, reclining as flowers mature; **leaves** glabrous, mainly basal, 2-5 mm. broad, up to 35 cm. long; **cauline leaves** reduced, the uppermost bractlike, subtending and exceeding inflorescence branches; **inflorescence** a terminal cyme and one to six lateral, often distant, cymes; **cymes** 1-3.5 cm. in diameter, branches terminating in glomerules of many crowded spikelets; **spikelets** 2.5-4 mm. long, broadly ovoid to subrotund, several-flowered but maturing only one or two fruits; **fruit** an achene, 1.3-1.6 mm. long, 1.2-1.5 mm. wide; **tubercle** 0.3-0.6 mm. high, deltoid-conical; **bristles** 1/2 to 3/4 as long as achene.



Pinehill beakrush

BLUE SEDGE

Carex complanata Torr. & Hook.

Blue sedge plants are stiffly erect and 3 feet tall or less. They form many-stemmed clumps from knotty rootstocks. They grow mostly on upland sites in association with bluestem and panicum grasses.

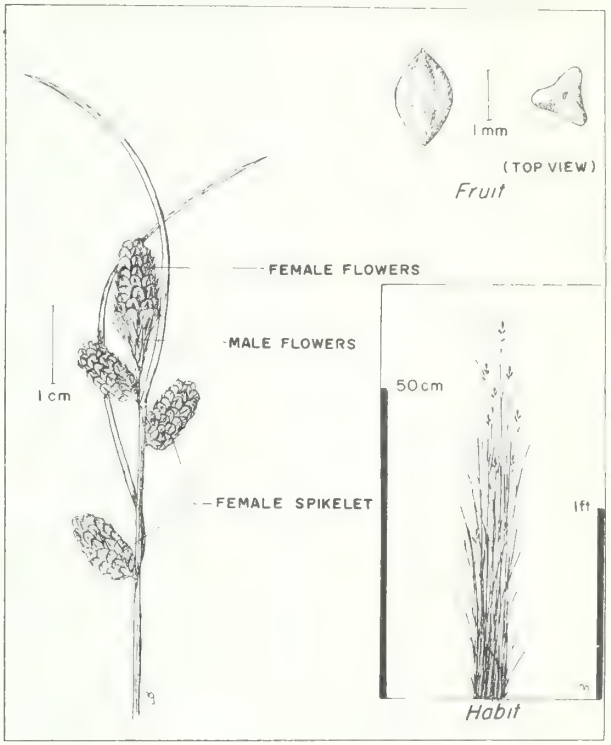
Flowers are unisexual, with male flowers found only basally on the uppermost spike of two to five spikes making up the inflorescence. Female flowers are on the upper part of this uppermost spike and on the other spikes. Spikes are densely flowered, ¼ to 1 inch long, and about ¼ inch wide. Bracts subtending each flower give the spikes a bristly appearance. The sac (perigynium) enclosing individual female flowers is flattened, with obtuse or rounded tips.

Leaves are stiff and erect, with blades about 1/16 inch wide. Although a few hairs are scattered on the leaf sheaths, plants generally appear smooth and hairless. Basal sheaths are purplish or reddish brown. Leaves seldom exceed the inflorescence, but one or two leaflike bracts may surpass the upper spike.

Although plants are often numerous, they produce little herbage. Hence, blue sedge seldom makes a major contribution to the cattle diet.

Range: Texas, Oklahoma, and Missouri to Georgia and Pennsylvania.

Perennial. **Stems** 30-120 cm. tall, stiff, erect, usually in small dense clumps from short, knotty rhizomes; **leaves** stiffly ascending; **blades** 2-4 mm. wide, elongate; **basal sheaths** purplish to brownish red, older sheaths becoming fibrous at base of stem; **inflorescence** of two to five spikes, the terminal spike staminate at base, pistillate above; other spikes pistillate; spikes 8-15 mm. long, 5-7 mm. thick, the terminal spike usually longest; **flowers** subtended by lanceolate, scarious-margined bracts; **staminate flowers** with three stamens; **pistillate flowers** with an ovary enclosed in a beakless, flattened, ovoid perigynium about 2 mm. long; **fruit** an achene 1.5-2 mm. long, triangular in dorsal outline, acute-ellipsoid in lateral outline.



Blue sedge

LURID SEDGE

Carex lurida Wahl.

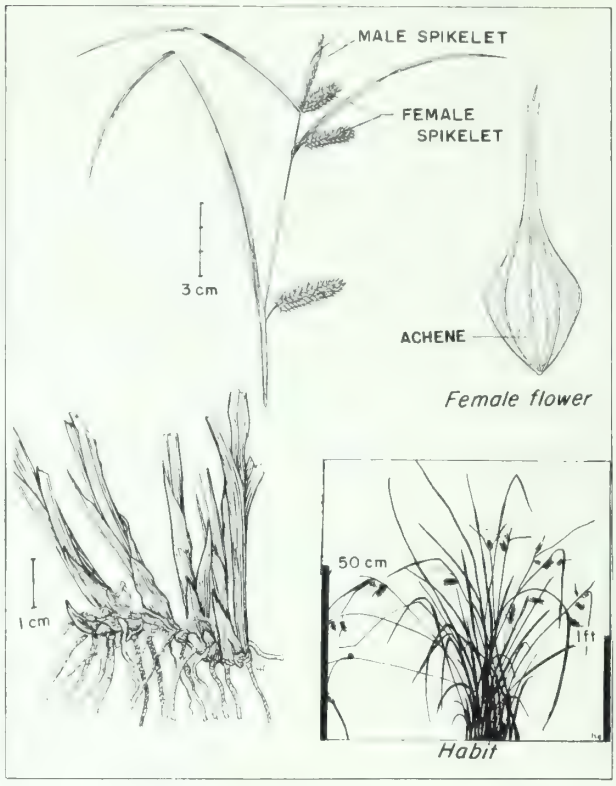
Lurid sedge grows 1 to 3 feet tall in wet woods or swampy sites, forming dense clumps from stout scaly rhizomes. The inflorescence consists of two to five spikes, the uppermost with male flowers, and those below with female flowers. Both male and female spikes are ½ to 3 inches long. Male spikes are only about ⅛ inch in diameter, however, while the female exceed ½ inch. Flowers appear early in spring, the spikes persisting through the growing season.

Leaves are about ¼ inch wide and 15 inches long. Stems are leafy throughout. The upper leaves, as well as the leaflike bract below the inflorescence, usually exceed the inflorescence in height. Leaf blades are yellow green (lurid); basal parts of lowest leaf sheaths are purplish.

Individual clumps of lurid sedge produce as much herbage as many of the grasses. Because plants are seldom abundant except on very wet sites, however, this species is not important for forage.

Range: Texas to Florida, north to Canada.

Perennial. **Stems** glabrous, 20-100 cm. tall, in dense clumps from short, stout rhizomes, usually bending somewhat under the weight of the spikes; **leaves** 2-7 mm. wide, 30-40 cm. long, pale green or yellow green, glabrous, upper leaves exceeding inflorescence; **inflorescence** a terminal staminate spike with one to four pistillate spikes below; **staminate spikes** 1-7 cm. long and 2-3 mm. thick; **pistillate spikes** burlike, 1-7 cm. long, 1.5-2 cm. thick; individual **flowers** subtended by lanceolate bracts; **staminate flowers** with three stamens; **pistillate flowers** with ovary enclosed in ovoid, beaked perigynium 6-9 mm. long, 2.5-3 mm. thick; **fruit** an obovoid, three-angled achene 2-2.5 mm. long.



Lurid sedge

ANNUAL SPIKESEDGE

Eleocharis microcarpa Torr.

Annual spikesedge inhabits wet meadows and swampy areas. It grows in small clumps with many hairlike flower stalks averaging 6 inches high. Each stalk ends in a single ovoid, several-flowered spikelet about ⅛ inch long. Spikelet scales are pale, and papery in texture. The inconspicuous basal leaves resemble the flower stalks but are usually shorter.

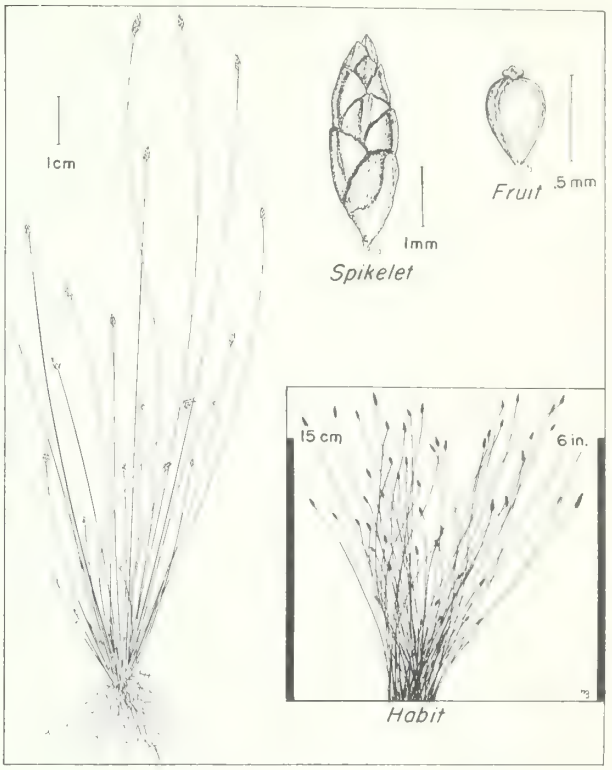
The fruits are barely visible to the naked eye. With magnification, they appear ovate in outline. They are three-angled in cross section, with prominent green ribs. The persistent base of the style forms a green cap (tubercle) at the apex.

Flowers appear in spring and seeds mature in early summer. Seeds germinate in late winter, and plants begin growth before most grasses. Cattle may graze this early herbage; otherwise annual spikesedge has little forage value.

Another annual, conecap spikesedge, *Eleocharis tuberculosa* (Michx.) R. & S., resembles it in size and general appearance, but is distinguishable by its large tubercle, which equals the seed in size. Hairsedge, *Bulbostylis capillaris* (L.) C. B. Clarke, another small, fine-stemmed annual, is recognizable by its clusters of brown, ovoid spikelets at the branch tips.

Range: Coastal Plain, Louisiana to Florida and Virginia.

Annual. **Stems** slender, four-angled, 5-30 cm. tall, in small, many-stemmed tufts; **leaves** reduced to slender basal sheaths similar to flower stalks in appearance; **inflorescence** a terminal spikelet, lanceolate to oblong or ovate, 2-7 mm. long, 1-1.5 mm. thick, several-flowered, lower flowers falling when mature; **flowers** enclosed by scarious-margined scales; **fruit** a three-angled, obovoid achene, 0.5 mm. in diameter with a minute warty tubercle at the top.



Annual spikesedge

COMMON RUSH

Juncus effusus L. var. *solutus* Fern. & Wieg.

Common rush, also called rice rush and soft rush, grows in swamps, along stream banks, or on other wet sites. Although typical *Juncus effusus* L. is not found in this country, the species is represented by several varieties. Only variety *solutus* occurs in the South.

Plant height averages 3 feet, but may reach 6 feet. Numerous round seedstalks arise from a stout rhizome to form dense clumps. The leaf is a brown sheath that encircles the seedstalk to a height of about 5 inches. The blade is reduced to a minute bristle at the sheath tip.

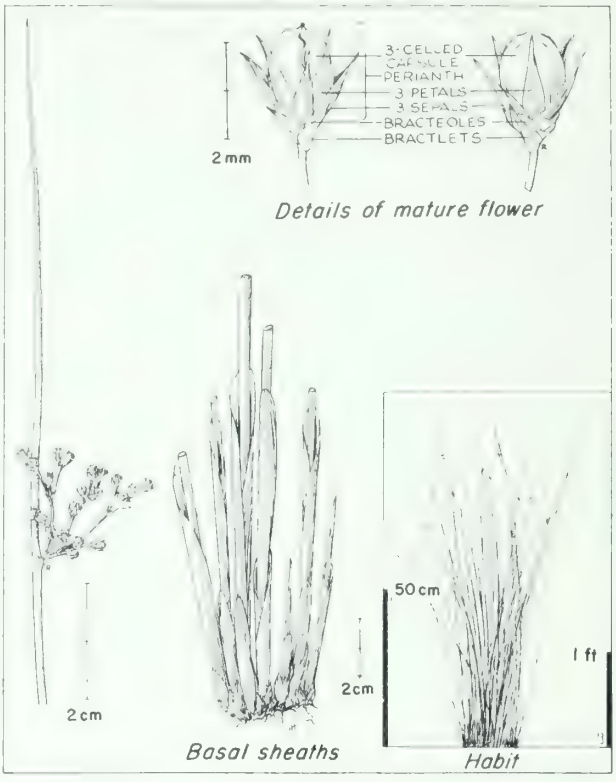
Flower clusters appear to emerge from one side of their flower stalk. Actually, the inflorescence is terminal, subtended by a single, erect bract that may be misidentified as a continuation of the stalk. Common rush is apparently the only southern freshwater rush with this characteristic.

When fully expanded, usually by May 1, the freely branching inflorescence is about 5 inches long. The many small flowers are single, each producing a capsular fruit that yields many tiny seeds.

New leaves and stalks of common rush are nutritious and palatable. Because of its scanty foliage, however, this species provides little forage.

Range: Throughout the United States and Canada.

Perennial. **Stems** 20-200 cm. tall, from stout rhizomes, forming dense clumps; **leaves**, the lower reduced to reddish brown basal sheaths, the upper including a slender scalelike **blade** 1 mm. long; **inflorescence** a terminal cyme 1-12 cm. in diameter; **flowers** borne singly on cyme branches; **sepals** three, acuminate, 2 mm. long; **petals** three, acuminate, approximately equaling sepals; **fruit** a capsule, equaling or slightly shorter than the perianth.



Common rush

NEEDLEPOD RUSH

Juncus scirpoides Lam.

Needlepod rush grows on riverbanks and in shallow ponds, swamps, and wet pinelands. It forms open clumps of slender stalks 1 to 3 feet tall, arising from thick, whitish rhizomes. Two or three leaves are spaced along the stalk, the uppermost subtending the inflorescence. Leaf sheaths, about 1 inch long, are split throughout their length. Blades are round in cross section, with hollow cores divided into chambers by regularly spaced partitions that impart a ribbed appearance to the surface. Leaves are about 4 inches long. They drop early, leaving a short stub.

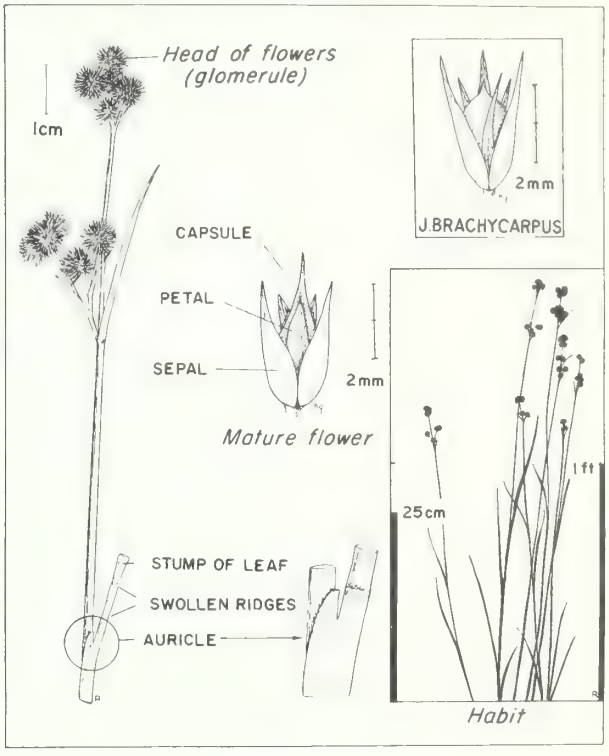
Inflorescences, when fully expanded, are about 3 inches long and 1 inch wide. Flowers are in heads that may be arranged in either a terminal cluster or in two distinct clusters, one terminal and the other 2 to 3 inches lower on the stem. Heads are each about ¼ inch in diameter and number up to five per cluster. One head per cluster is attached directly to the stem; the others are on short stalks.

Needlepod rush resembles whiteroot rush, *J. brachycarpus* Engelm., and the two frequently occur together. The seed capsule of needlepod rush ends in a sharp beak that extends beyond the tips of the flower petals and sepals, while the short-beaked capsule of whiteroot rush is exceeded by the floral bracts.

Because of its dearth of foliage, needlepod rush has little forage value.

Range: Texas to Florida, north to Oklahoma, Missouri, Illinois, and New York.

Perennial. Stems erect, 30-80 cm. tall, from stout rhizomes; leaves terete, 1-2 mm. in diameter, 5-15 cm. long, conspicuously septate; sheaths open and slightly inflated, with a conspicuous auricle; inflorescence a cyme 3-15 cm. long by 2 cm. wide, with 4-15 spherical heads; heads 5-12 mm. in diameter, 15-40 flowered; sepals three, rigid, lance-subulate, 3 mm. long; petals three, similar to sepals but slightly shorter; fruit a subulate capsule, equaling or usually exceeding the perianth.



Needlepod rush

ROUNDHEAD RUSH

Juncus validus Coville

Roundhead rush grows mainly in swales, drainages, and sandy flatwoods. It forms loose, leafy clumps of stems 2 to 3 feet tall. Although it is not generally abundant, its large, stiff inflorescence is conspicuous.

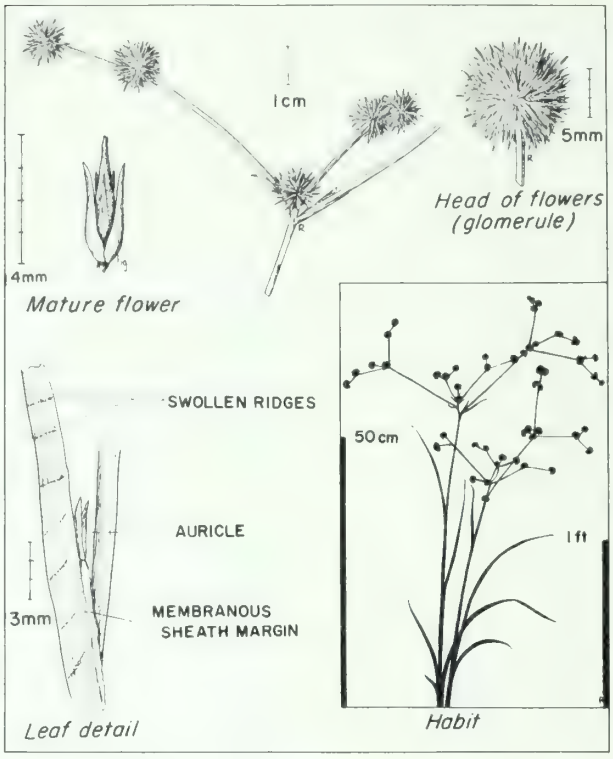
Flower stalks emerge in midspring and seeds mature by early summer. The inflorescence branches as it grows, often spreading to a foot or more at maturity. Spherical flower heads, about ½ inch in diameter, are scattered throughout the inflorescence.

Leaves are mostly basal, the largest about 12 inches long and ¼ inch wide. They are slightly flattened, hollow, and segmented by internal partitions that impart a knotty feel to the surface. This "knotleaf" characteristic is common to several species, however, including needlepod rush. The flattened leaves of roundhead rush superficially resemble those of iris *(Iris* spp.) and blue-eyed-grass *(Sisyrinchium* spp.), but the knotty blades are useful in distinguishing the species before flower stalks appear. The closely related flatleaf rush, *Juncus polycephalus* Michx., has strongly flattened leaves and its capsules are capped by a solid beak, not split at the tip as in roundhead rush.

Roundhead rush is fair forage in late winter and early spring. Cattle graze it little, if any, the rest of the year.

Range: Texas to Mississippi and Missouri.

Perennial. **Stems** erect, 30-80 cm. tall, from short, knotty **rhizomes**; **leaves** 2-7 mm. wide, up to 40 cm. long, conspicuously septate; **sheaths** scarious-margined, terminated by lanceolate auricles 2-4 cm. long; **inflorescence** an open, widely branching cyme, up to 50 cm. wide, with spherical, many-flowered heads at branch tips and in axils; **heads** 1-1.5 cm. in diameter; **flowers** with sepals and petals equal, lance-subulate, 4-6 mm. long; **fruit** a lance-subulate capsule, exceeding the perianth.



Roundhead rush

POVERTY RUSH

Juncus tenuis Willd.

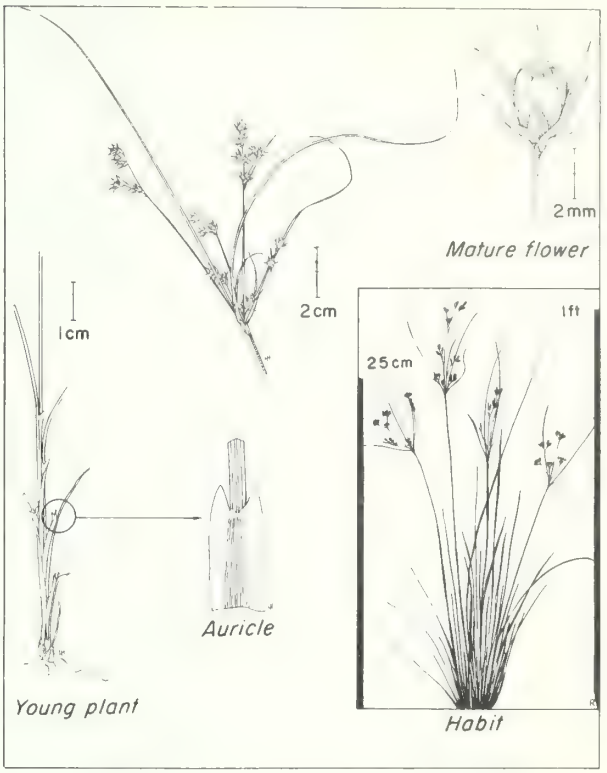
Poverty rush, known also as hemp rush and wiregrass rush, grows along trails, in yards, and in other places with heavy traffic. It starts growth in late winter, producing small, dense clumps. Mature stalks reach about 2 feet in height. Leaves are mostly basal, usually less than 1/25 inch wide and about half as tall as the flower stalks. Flowers appear in early spring and seeds mature in April or May. Inflorescences rarely exceed 3 inches in length and 1 inch in width. Flowers, about ⅛ to 3/16 inch in diameter, are borne singly. Leaflike bracts subtend the inflorescence. They are long and narrow, extending above the uppermost flower.

Poverty rush resembles another low-growing rush, *Juncus dichotomus* Ell., which grows, however, mainly on undisturbed sandy sites. Whereas leaves of poverty rush are flattened, those of *J. dichotomus* are almost cylindrical. In poverty rush, a membranous auricle extends beyond the summit of the leaf sheath; the short, rounded auricle of *J. dichotomus* is barely perceptible. Because the leaves of both species are narrow, magnification helps in detecting these differences.

Poverty rush is seldom grazed except in winter when better herbage is unavailable. On most sites. it supplies little forage.

Range: Throughout most of North America.

Perennial. **Stems** in clumps, 10-60 cm. tall; **leaves** basal, about one-half the height of stems, 0.5-1 mm. wide; **sheath** with scarious margin; **auricle** scarious, 1-3 mm. long; **inflorescence** a cyme 1.5-15 cm. long, subtended by involucral bracts that often exceed the cyme; **flowers** 3-5 mm. in diameter, borne singly at tips and in axils of ascending branches of cymes; **sepals** and **petals** lance-subulate, scarious-margined, equal in size; **fruit** a capsule, usually exceeded by the perianth.



Poverty rush

TWINFLOWER RUSH

Juncus biflorus Ell.

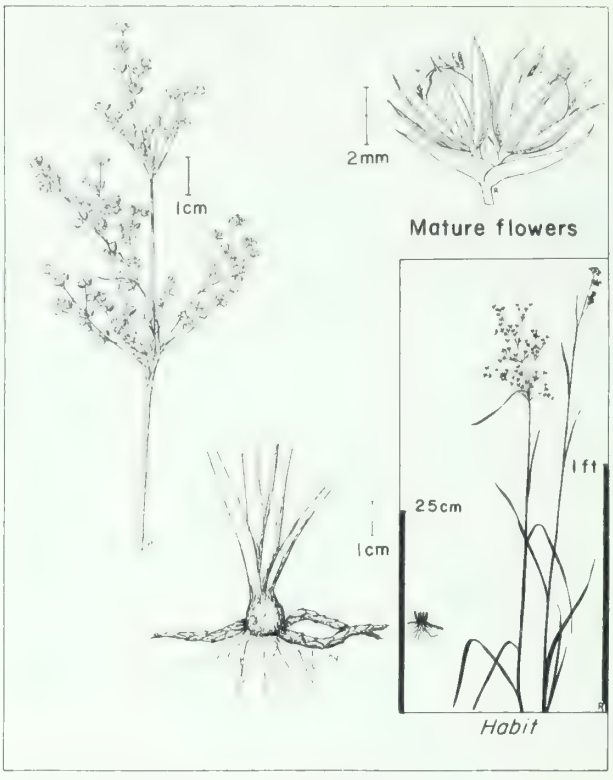
Although not abundant, twinflower rush is conspicuous at maturity because of its tall flower stalks and large brown seed heads. It grows mainly on wet meadows or drainageways. Flower stalks 2 to 4 feet tall are produced in spring from coarse rhizomes. Inflorescences, appearing almost simultaneously with the stalks, are 2 to 8 inches long, but usually about 4 inches. They are profusely branched, the branches ascending at angles of 45° or less. Flowers are numerous, small, and brown. Usually two or more are borne at each branch tip and in the axil of each branch. At maturity, normally in May, seed capsules are spherical. Inflorescence characters are reliable in identification, as no other rush common to the longleaf pine-bluestem type closely resembles twinflower rush.

Basal leaves are ¼ inch wide and up to 12 inches long. Upper leaves are somewhat reduced. Lower leaves usually turn brown before seeds mature.

Young leaves provide some early green forage for cattle, but the plant is not abundant enough to contribute appreciably to the diet.

Range: Texas to Florida, north to Massachusetts, southern Michigan, Illinois, Missouri, and Oklahoma.

Perennial. Stem 60-130 cm. tall, forming loose clumps from scaly rhizomes; **lower leaves** 4-7 mm. wide and 15-30 cm. long, the upper about ½ the size of the lower; **inflorescence** a cyme 5-20 cm. long, branches ascending; mature **flowers** 1.5-3.0 mm. in diameter, in clusters of two to several at tips and in axils of inflorescence branches; **sepals** three, acuminate; **petals** three, blunt, scarious-margined; **fruit** a capsule, equaling the perianth.



Twinflower rush

FORBS

Forbs are numerous on longleaf pine-bluestem ranges, occasionally comprising up to 20 percent of the ground cover. They may add variety to the forage supply, provide food and cover for wildlife, and improve the soil. On the average, forbs furnish about 4 percent of the cattle diet. Because many species surpass grasses in content of protein, phosphorus, and calcium, the quantity consumed is not a reliable indication of their contribution to cattle nutrition.

Several forbs are toxic, but cattle poisoning is infrequent. These plants are usually unpalatable; moreover, they seldom are abundant enough to cause trouble. With rare exceptions, cattle consume poisonous species in lethal quantities only on overgrazed ranges.

Although forbs representing dozens of plant families are found in the South, the most common species on longleaf pine-bluestem range are legumes (Leguminosae) and composites (Compositae).

LEGUMES

The legumes or Leguminosae are economically one of the most important plant families. They include peas, beans, peanuts, and many valuable pasture plants—clovers, alfalfa, vetch, and lespedeza. They vary widely in life form, from annual forbs to trees over 100 feet tall. Although they are generally characterized by compound leaves, irregular pealike flowers, and seed pods that split longitudinally when ripe, these features are far from universal. Some legumes have simple leaves, several have symmetrical flowers, and pods of some species remain closed at maturity.

Native legumes are numerous on longleaf pine-bluestem ranges but usually comprise a small part of the total forage. Legume herbage is rich in protein; thus, small quantities may appreciably improve the diet. Most herbaceous legumes are palatable to cattle, but a few species—Nuttall wildindigo, for example—are grazed sparingly, if ever.

Seeds of many legumes are favorite foods of wildlife. Several species are grown in cultivated food patches to improve quail habitat.

Key to legumes

1 LEAVES SIMPLE; flowers yellow, borne in racemes, inconspicuous, pealike

2 Blades orbicular, stipules lanceolate; pods flat

Rhynchosia reniformis, dollarleaf rhynchosia

2 Blades lanceolate to linear; stipules sagittate; pods inflated

Crotalaria sagittalis, arrow crotalaria

1 LEAVES COMPOUND; flowers various colors and forms

3 Leaflets three

4 Plants annual, small; leaflets oblong-obovate; flowers pink; pods flat, indehiscent

Lespedeza striata, common lespedeza

4 Plants perennial

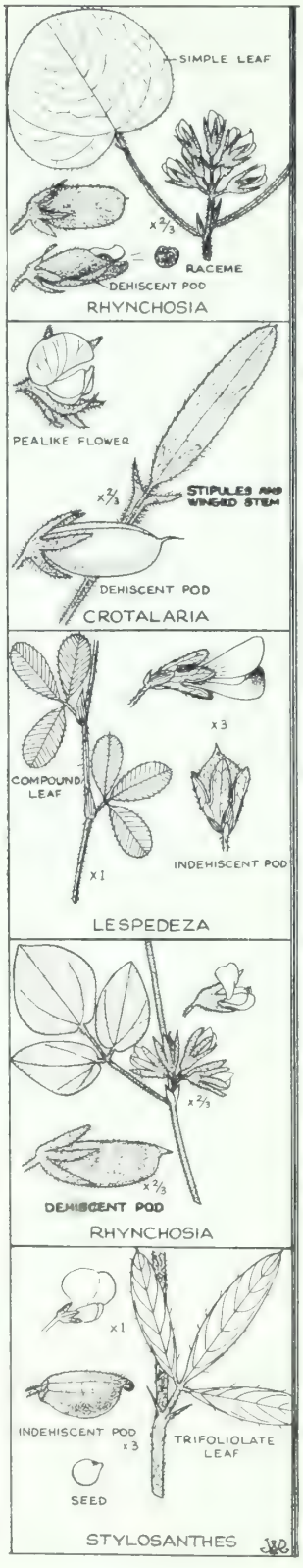
5 Trailing or climbing vines from a tuber; leaflets ovate to rounded; flowers yellow; pods flat, dehiscent

Rhynchosia difformis, hairy rhynchosia

5 Herbs from woody rootstocks

6 Plants weak, slender; less than 50 cm. tall; flowers yellow orange

Stylosanthes biflora, pencilflower



6 Plants robust, over 50 cm. tall

7 Pods inflated; flowers yellow; leaflets obovate, drying blackish

Baptisia nuttalliana, Nuttall wildindigo

7 Pods flat, constricted into small "sticktights;" flowers rose purple or white; leaflets of various shapes, drying green

Desmodium spp., tickclovers

3 Leaflets more than three

8 Leaves once-pinnate; pods long, slender, flat

9 Flowers pealike; leaflets odd numbered

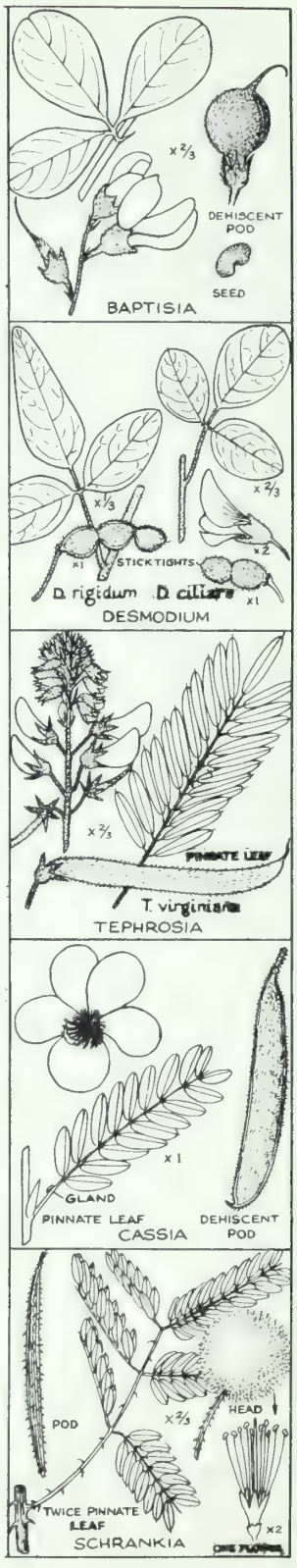
Tephrosia spp., tephrosias

9 Flowers with five similar petals (not pealike); leaflets even numbered

Cassia fasciculata, showy partridgepea

8 Leaves twice pinnate; pods long, slender, prickly, and 4-angled; stems herbaceous, vinelike; flowers many, small, rose pink, in spherical heads

Schrankia uncinata, catclaw sensitivebrier



ARROW CROTALARIA

Crotalaria sagittalis L.

Arrow crotalaria is an annual or a short-lived perennial seldom more than 15 inches tall. It is most common on dry sandy or gravelly soils, especially on disturbed sites. The lower leaves are elliptical and about 1 inch long, whereas upper leaves are lanceolate and up to 3 inches long. The arrowhead-shaped stipules give stems a winged appearance. The flowers, which usually appear from June through September, are small and yellow, resembling those of garden peas. The inflated pods are about 1 inch long and half as broad.

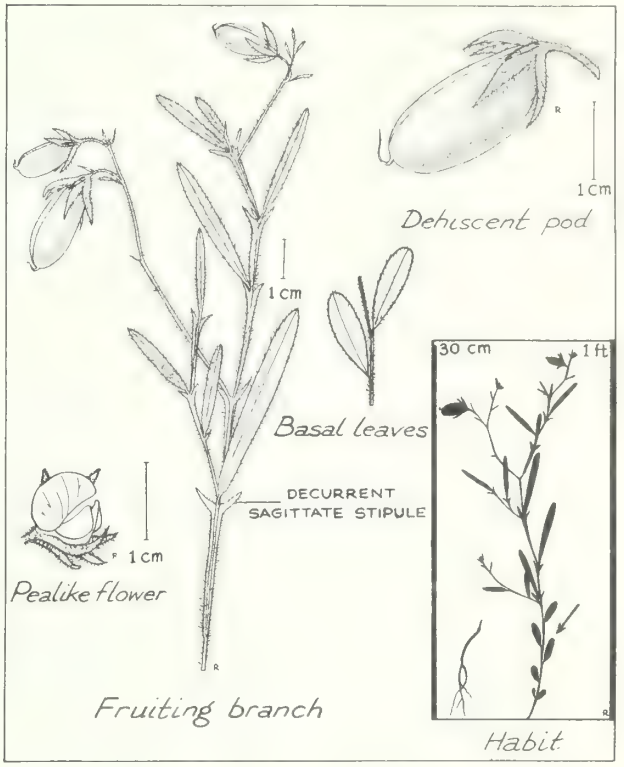
Several other crotalarias resemble arrow crotalaria in flower and pod characteristics but only one, *Crotalaria purshii* DC., has the same long narrow leaves. The principal difference between the two is that stems and sepals of arrow crotalaria are conspicuously hairy, while those of *C. purshii* have short and obscure hairs. Some taxonomists consider *C. purshii* a regional variety of arrow crotalaria.

The crotalarias are often called rattleboxes, since the loose seeds rattle in the mature pod.

Arrow crotalaria is poisonous to livestock. Because plants are usually scarce they rarely constitute a threat to cattle.

Range: From Texas to Florida north to South Dakota and Massachusetts.

Annual or weak perennial. **Stems** 10-40 cm. tall, simple to bushy branched, loosely villous to hirsute; **basal leaves** simple, small, oval; **upper leaves** linear-oblong to lanceolate, the larger 3-7 cm. long, 8-15 mm. wide; **stipules** inversely sagittate, decurrent; **flowers** papilionaceous, two to four on terminal or axillary peduncles 1-4 cm. long; **calyx** 10-12 mm. long, five-cleft, loosely villous or hirsute; **corolla** 8-10 mm long, yellow; **legume** 1.5-3 cm. long, 1 cm. thick, strongly inflated, dull brown; **seeds** 2.3-3 mm. broad, obliquely reniform.



Arrow crotalaria

COMMON LESPEDEZA

Lespedeza striata (Thunb.) H. & A.

Common lespedeza, or Japanese clover, is an annual forage legume indigenous to Asia. Following its introduction into Georgia more than 100 years ago, it escaped cultivation and spread rapidly across the South. Now it is common on dry sites of open, closely grazed range, but occurs rarely under timber stands.

Plants are usually less than a foot tall. Stems are many-branched and frequently prostrate. Leaves are trifoliolate, the obovate to nearly elliptical leaflets 1/3 inch to 1 inch long. Leaflet veins are conspicuous, with straight, parallel laterals extending outward at about 45° from the midrib. Flowers are of two kinds, with and without corolla, and are borne singly or in clusters of two to four in upper leaf axils. Corollas of complete flowers are pinkish and about ¼ inch long.

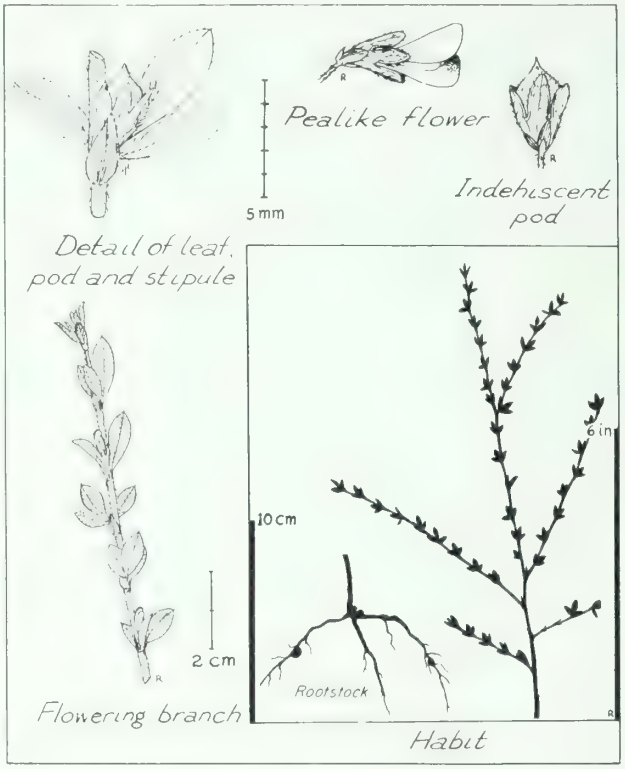
Several native lespedezas also grow on longleaf pine-bluestem range. Among the most common are hairy lespedeza, *L. hirta* (L.) Hornem., and slender lespedeza, *L. virginica* (L.) Britt. Both are perennials, and neither is an important forage producer. Hairy lespedeza is distinguishable by its height, which reaches 4 feet, and its large leaflets—up to 2 inches long and an inch wide. Slender lespedeza may resemble common lespedeza in size, but is upright in habit and has leaflets four to six times longer than wide.

Lespedezas may be confused with tickclovers. Both have trifoliolate leaves subtended by stipules, and their flowers are similar. They can readily be distinguished by their seed pods. Lespedeza pods are short, oval, usually one-seeded, and intact at maturity, while those of tickclovers are elongate and break into two or more one-seeded segments at maturity. Lespedezas also lack the stipels that subtend tickclover leaflets.

Like most pasture legumes, common lespedeza is nutritious and palatable but seldom abundant in the native vegetation. It is often an important constituent of seeded firebreaks on forest ranges. Its ability to produce seed under close grazing makes common lespedeza a reliable source of quail food; these birds also eat the spring leaves.

Range: Texas and Florida, north to Kansas and Pennsylvania.

Annual. **Plants** decumbent 10-40 cm. tall, diffusely branched; **stems** retrorsely pubescent; **leaves** pinnately trifoliolate; **stipules** ovate-lanceolate, persistent, brown, scarious, prominently veined, 4-6 mm. long; **leaflets** short-petioled, oblong-obovate, 1-2 cm. long, striate; **flowers** of two kinds, apetalous ones mixed with complete pinkish ones in axils, one to four on short peduncles; **legume** a tiny, flat, one-seeded pod barely exceeding the persistent calyx.



Common lespedeza

SHOWY PARTRIDGEPEA

Cassia fasciculata Michx.

Showy partridgepea grows on a variety of sites throughout the Eastern United States. It is common on disturbed areas, often forming extensive colonies along firelines, roadside ditches, and in old fields.

Plants differ widely in several characters, particularly size and pubescence, and at least five variants have been named. These are extremely difficult to identify consistently, and the whole species complex is treated here as a single entity.

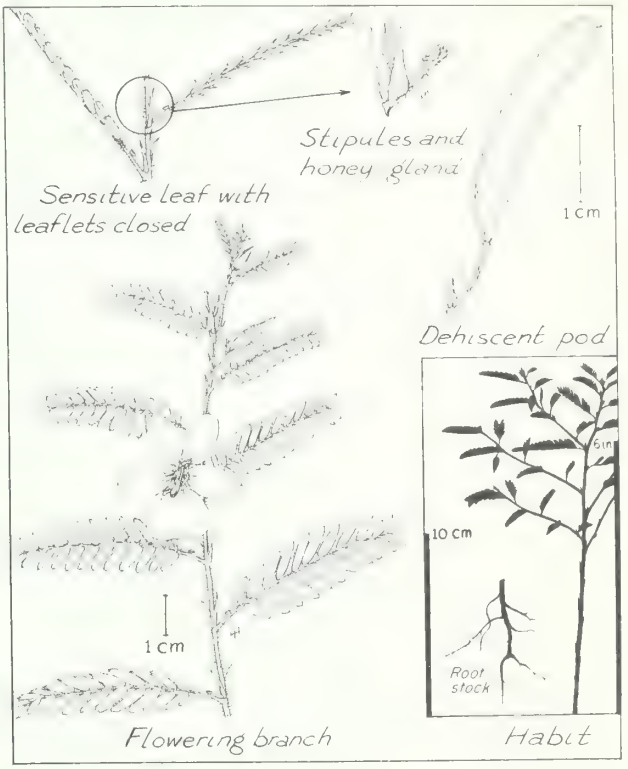
Plants are normally annuals, though a perennial form has been reported from the sandy pinelands of Alabama and Florida. Height is usually about 2 feet, but ranges from 6 inches to 3 feet. In years of normal rainfall, the bright yellow flowers appear continuously through most of the growing season. The leaves are pinnately compound with 10-15 pairs of leaflets. They are sensitive, folding together when touched, and closing at night. A small, dark, saucer-shaped nectary, or honey gland, is located on the leaf petiole slightly below the lowest pair of leaflets.

Flowers of sensitive partridgepea, *Cassia nictitans* L., resemble those of showy partridgepea but are much smaller, having five stamens as compared to ten in showy partridgepea.

Although the foliage is highly nutritious, range cattle graze partridgepea sparingly. The seeds are readily eaten by quail. Small patches are widely cultivated in the South to augment natural food supplies. Periodic burning favors partridgepea.

Range: All of Eastern United States, from Texas and Florida north to South Dakota and Massachusetts.

Annual. **Stems** 0.5-1 m. tall, simple to much branched, pubescent to villous; **leaves** 3-6 cm. long, sensitive, even-pinnately compound, with a nectary on the petiole; **stipules** persistent, narrowly linear to lanceolate; **leaflets** 10-15 pairs, 10-20 mm. long, 3-5 mm. wide, linear-oblong; **flowers** showy, in axillary fascicles of one to four; **petals** bright yellow, 1-2 cm. long, obovate, the upper ones marked with deep red in the center, the lowest one the largest of the five; **stamens** 10, conspicuous; **legume** 2.5-5 cm. long, 5-7 mm. wide, flat, pubescent to villous; **seeds** 4-12 per legume, 3.5 mm. long, 2.5-4 mm. broad, dark



Showy partridgepea

PENCILFLOWER

Stylosanthes biflora (L.) BSP.

Pencilflower is a small perennial common on longleaf pine-bluestem range. It is usually most abundant on sandy sites.

Plants vary widely in height, branching habit, size, and shape of leaflets, and hairiness. Varietal names have been assigned, but intergradation makes identification difficult.

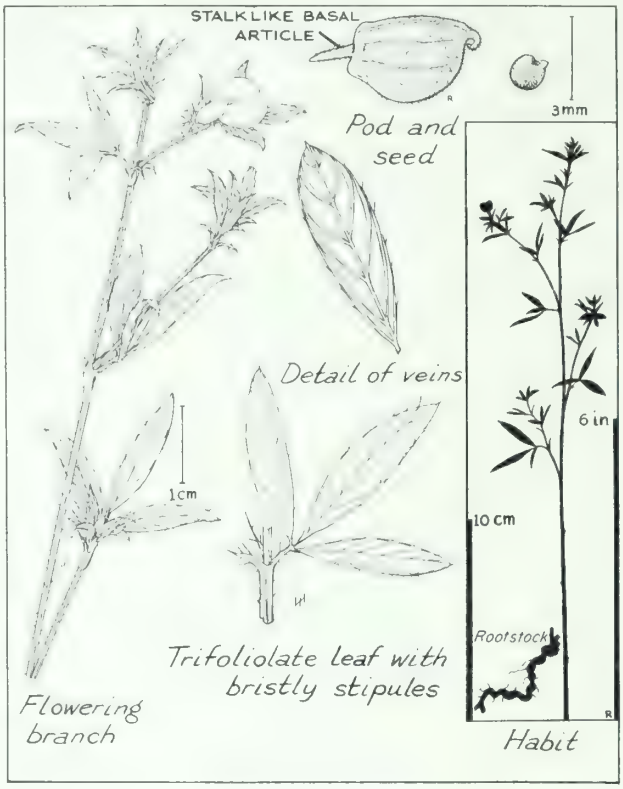
Plants seldom exceed 12 inches in height, and are inconspicuous except for the pencil-yellow, pealike flowers that appear throughout the growing season. Flowers ¼ to ½ inch long are in short tight spikes at branch tips. Pods are small and inflated, with a sterile, stalklike basal article. Leaves are trifoliolate with elliptical leaflets about ¾ inch long.

Without flowers, pencilflower resembles other small-leaved legumes, especially lespedezas and tickclovers. It is distinguishable, however, by leaf characters, the veins on the underside of the leaflets being distinctly lighter in color than the blade and conspicuously thickened. Veins of lespedezas and tickclovers are relatively slender, and their color resembles that of the blade.

The seed is eaten by quail. The leaves and stems are nutritious and palatable to cattle, but plants are small and usually widely scattered, and forage yield thus is negligible.

Range: Texas to Florida, north to Kansas, Illinois, Indiana, and New York.

Perennial. Stems 10-40 cm. tall, stiff, erect, branching or unbranched, finely pubescent to long-hirsute, often bristly at the summit; leaves trifoliolate; stipules sparsely to densely bristly, narrow, united with the petiole for about 2/3 of their length; leaflets narrowly lanceolate to elliptic, subulate-tipped, 1.5-4 cm. long, margins entire to bristly ciliate; flowers papilionaceous, on a stalklike hypanthium; calyx glabrous, early falling; corolla yellow with pink veins on the back; fruit, a loment 4-5 mm. long with one to two articles, the terminal one turgid, thinly hairy, reticulate with an incurved beak (style), the basal one undeveloped, stalklike.



Pencilflower

DOLLARLEAF RHYNCHOSIA

Rhynchosia reniformis (Pursh) DC.

Dollarleaf rhynchosia is a small, erect perennial found throughout the Gulf Coastal Plain. It is most abundant on sandy sites.

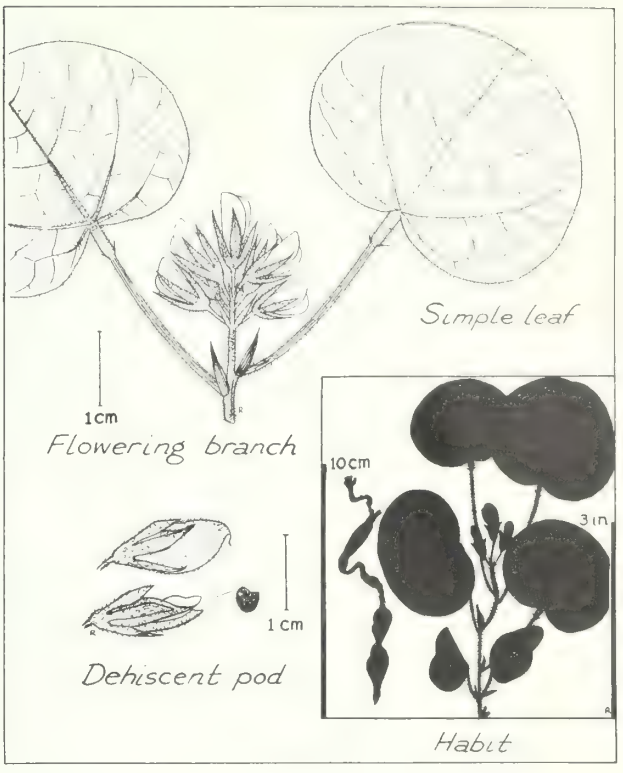
Stems are 3 to 9 inches tall from slender, woody rhizomes. Leaves are simple or rarely trifoliolate, and round to kidney shaped, averaging about 2 inches in diameter. Both surfaces are sparsely to densely pubescent.

Small, yellow, pealike flowers are borne in both terminal and axillary clusters. Pods are about ½ inch long and densely hairy.

Dollarleaf rhynchosia is readily distinguishable from related species by its large, round leaves. Plants are grazed by cattle but contribute little to the diet, because they generally comprise a small fraction of the forage. Quail eat the seeds.

Range: Texas to Florida, north to North Carolina.

Perennial. **Stems** erect, densely pubescent, from long slender rhizomes, 5-25 cm. tall, hirsute on the angles with spreading or reflexed hairs; **leaves** simple, the blades 2-5 cm. long, 2-8 cm. broad, orbicular to reniform, strongly reticulate, resin-dotted with appressed pubescence on veins; **flowers** in short, dense axillary or terminal racemes 2-3 cm. long; **calyx** 8-10 mm. long; **corolla** yellow, 7 mm. long; **legume** flat, oblong, 1.5 cm. long, 6 mm. wide, obscurely falcate, pubescent, resin-dotted; **seeds** lenticular, 3 mm. broad, brownish, mottled with black.



Dollarleaf rhynchosia

HAIRY RHYNCHOSIA

Rhynchosia difformis (Ell.) DC.

Hairy rhynchosia is a perennial herbaceous vine with conspicuously ovate leaflets. Most leaves are trifoliolate with terminal leaflets about 1½ inches long and almost round. Lateral leaflets are smaller, and longer than broad. Basal leaves often develop only a single leaflet. Although differences among leaves are alluded to in its specific name, *difformis*, meaning "two forms," several rhynchosias have this character.

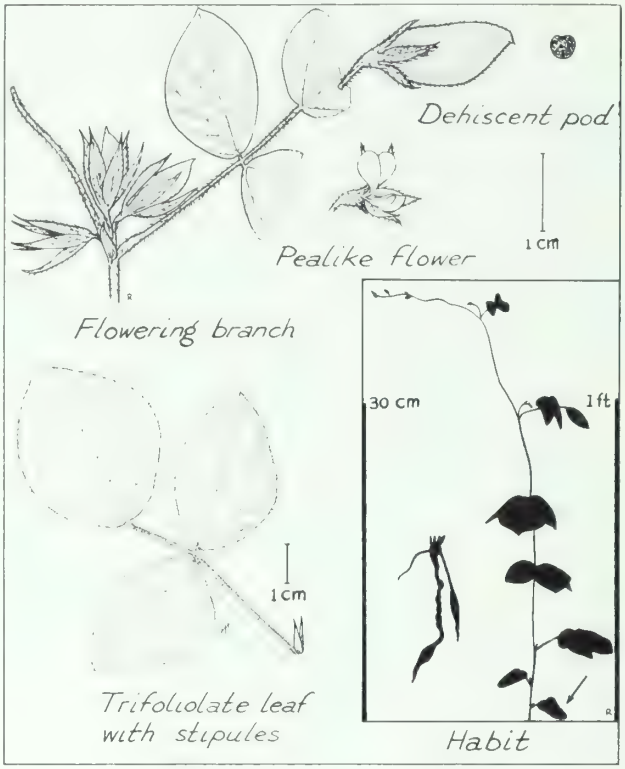
Stems arise from tuberous rootstocks, and may reach 3 feet. They are erect when young, but become trailing or twining as they elongate. Inconspicuous yellow flowers about ½ inch long are in short-stemmed axillary clusters.

Species that may be confused with hairy rhynchosia include broadleaf rhynchosia, *R. latifolia* Nutt., and erect rhynchosia, *R. tomentosa* (L.) H. & A. Whereas racemes of hairy rhynchosia measure only ¾ to 1⅛ inches, those of broadleaf rhynchosia are 3 to 7½ inches. *R. tomentosa* grows upright and has only trifoliolate leaves; paradoxically, it is more hairy than hairy rhynchosia.

Although hairy rhynchosia probably is the most abundant species of the genus on longleaf pine-bluestem range, the plants are too scattered to produce much forage. Most rhynchosias are good quail food plants.

Range: Texas to Florida, north to Missouri and Virginia.

Perennial. **Stems** from long tuberous roots, erect at first, then trailing and twining, to 1 m. long, densely retrorse-hirsute on the angles, lightly pubescent between; **leaves** of two kinds, the basal ones simple, reniform, those above trifoliolate; **leaflets** elliptic to broadly ovate, 2-5 cm. long, the terminal largest, sparingly pubescent on both sides; **flowers** in short, dense, axillary racemes, 2-3 cm. long; **corollas** yellow, 9-14 mm. long; **legume** 1.5 cm. long, 8 mm. wide; **seeds** lenticular, 2.5-3 mm. in diameter, dark brown



Hairy rhynchosia

CATCLAW SENSITIVEBRIER

Schrankia uncinata Willd.

Catclaw sensitivebrier is a close relative of the silktree, commonly called mimosa, and the cultivated acacias. Its spherical rose-pink flower heads resemble minature mimosa heads.

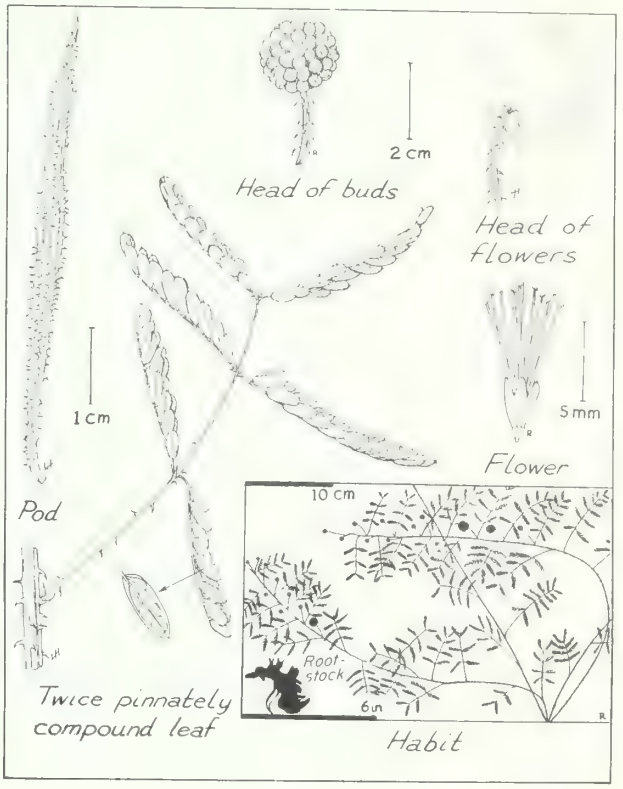
Catclaw sensitivebrier is a spiny, sprawling, perennial herb usually found on dry, sandy soils. Many prostrate stems 3 to 4 feet long arise from a large woody rootstock. Flowering begins in late spring and continues through the summer, or as long as stem growth continues. Leaves are bipinnate, with 4 to 8 pairs of first-division units, called pinnae. Each pinna has 8 to 15 pairs of oblong to elliptical leaflets ⅛ inch to over ¼ inch long. As in partridgepea, leaflets fold when touched.

Only one other sensitivebrier is likely to be encountered on longleaf pine-bluestem range. This is littleleaf sensitivebrier, *S. microphylla* (Dryand.) Macbr., which also grows on sandy sites throughout the South, especially in Florida and Alabama. Although more widely distributed, it is less common than catclaw. The two species differ primarily in venation, leaflets in catclaw having conspicuous lateral veins, but in littleleaf appearing to have only a midrib.

Cattle graze the tender twigs in early spring before the spines harden. Nutritive value is high: protein content of new growth reportedly reaches 45 percent. Plants are seldom abundant enough to contribute greatly to the cattle diet. This species is generally considered more important as an indicator of high or improving range condition than as a forage producer. Deer browse the stems and leaves, and quail eat the seeds.

Range: Texas to Alabama, north to Nebraska, Illinois, and North Carolina.

Perennial. Stems elongate, decumbent, angled, prickly, to 1 m. long; leaves bipinnate, 6-15 cm. long, sensitive; pinnae 4-8 pairs, 2-5 cm. long; leaflets 8-15 pairs, oblong-elliptic, 3.5-9 mm. long, veins prominent; flowers in spherical, long-peduncled, axillary heads 2-2.5 cm. in diameter; pods linear, strongly thorny-ribbed, 4-12 cm. long, with a slender beak at the apex.



Catclaw sensitivebrier

VIRGINIA TEPHROSIA

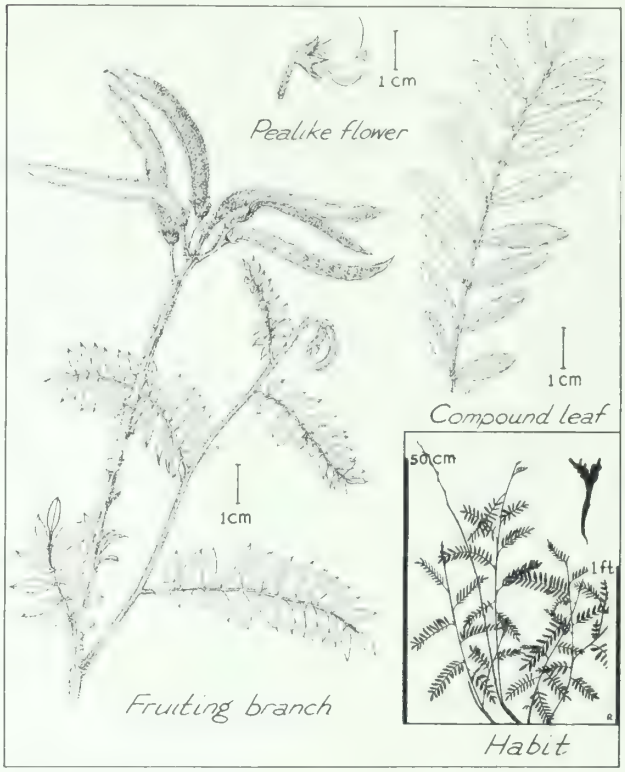
Tephrosia virginiana (L.) Pers.

Virginia tephrosia—also called goatsrue or devils-shoestring—is often the most abundant forb on dry, sandy sites that are periodically burned. Following fire, new shoots grow rapidly from the woody root-stocks. Although leaves are similar to those of partridgepea, once-pinnate with from 11 to 27 leaflets, they end in a single leaflet, while partridgepea leaflets are evenly paired throughout. Stems and the undersides of leaflets, especially on new growth, are densely coated with gray hairs. Plants may reach 20 inches in height and often grow in clumps up to 30 inches in diameter. Flowers are produced in terminal clusters in spring, but spring or summer burning may prolong flowering. The corolla of the pealike blossom consists of one cream to yellow petal and three rose petals. Pods are about 2 inches long and covered with gray hair.

Cattle rarely eat Virginia tephrosia, even on heavily grazed range. The seeds rate fair as quail food, being taken mainly when other food is scarce.

Range: Texas to Florida, north to Minnesota and Massachusetts.

Perennial. **Plants** conspicuously pubescent to villous; **stems** 30-60 cm. tall, erect or ascending from a branched woody crown and long woody roots; **leaves** odd-pinnate, 6-10 cm. long, nearly sessile; **leaflets** 11-27, elliptic to linear-oblong, 1-3 cm. long, 4-8 mm. wide, apex mucronate; **flowers** papilionaceous, bicolored; **racemes** compact, 4-8 cm. long, leafy in the lower flowering nodes; **standard** 14-21 mm. long, lemon yellow to cream; **wings** and **keel** rose; **legumes** 3-5 cm. long, straight to slightly curved, sparsely to densely strigose; **seeds** 6-11, bean shaped, 3.2-4.2 mm. long, brown variegated with black.



Virginia tephrosia

WEAK TEPHROSIA

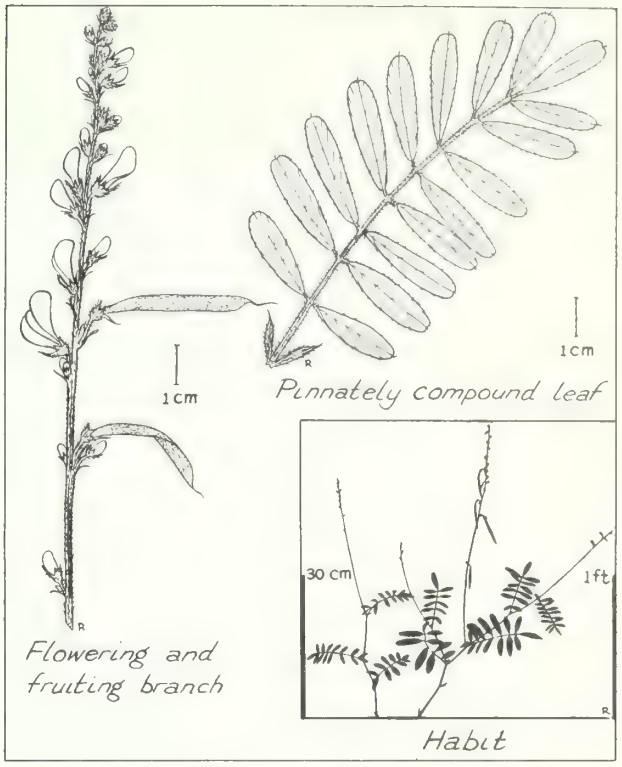
Tephrosia onobrychoides Nutt.

Although it does not thrive on as dry sites as Virginia tephrosia, weak tephrosia is common on sandy soils. It is a perennial from a woody rootstock. Stems usually are in clumps of two or three and generally less than 2 feet tall. Stems may branch several times, with each branch ended by an elongate, leafless raceme of white to reddish-purple flowers. The upper half of the stalk—unlike that of Virginia tephrosia—is leafless. Flowers appear in May and June, or later if the range is burned in spring or summer. The flat, hairy pods, 2 inches long or less, have up to 10 small, black seeds. Leaves are once-pinnate with 11 to 25 leaflets.

Cattle graze young growth on newly burned or heavily used range, but older foliage is usually rejected. Seeds are eaten by quail.

Range: Texas and Oklahoma to southern Missouri and Alabama.

Perennial. **Stems** pubescent to strigose with rusty hairs, erect to decumbent from a stout, woody crown and woody taproot; **leaves** odd-pinnate, 8-22 cm. long, on a petiole 7-35 mm. long; **leaflets** of the principal leaves 11-25, linear-oblanceolate and slightly broadened upward, 1.5-5.5 cm. long, 4-16 mm. wide, the apex obtuse, rounded or truncate, emarginate, glabrous to pubescent above, more or less silky-pilose with gray to rusty hairs beneath; **flowers** 15-20 mm. long in long terminal or axillary racemes much exceeding the foliage; **corolla** white, becoming crimson in age, pink or purple upon drying; **legumes** straight or slightly curved downward, 3.5-5 cm. long, 4-5 mm. wide, pubescent; **seeds** 3-10, 3-5 mm. long, smooth and mottled with black.



Weak tephrosia

LITTLELEAF TICKCLOVER

Desmodium ciliare (Muhl.) DC.

The tickclovers, also called beggarlice, sticktights, or ticktrefoils, are so named because the flat, minutely bristled fruits stick to clothing and animal hair. Several species, all perennials, are common throughout the South. Littleleaf tickclover is the most important on longleaf pine-bluestem range.

Leaves are pinnately trifoliolate. Leaflets are oval, blunt-tipped, 1/3 to 1 inch long, and uniform in size and shape. Flowers are small, purplish red and pealike. The fruit is a loment that may remain intact at maturity or break apart at its one to three joints to become the familiar "ticks" or "beggarlice."

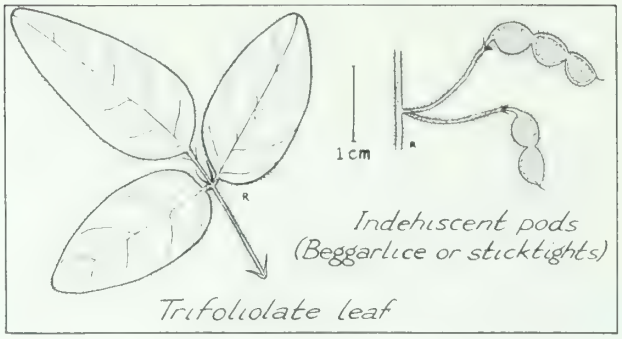
The similar rigid tickclover, *Desmodium rigidum* (Ell.) DC., also grows on Coastal Plain range. It can be distinguished by its leaflets, which are long-ovate instead of blunt-tipped, and unequal in size, the terminal longer than the laterals.

Although tickclovers are readily distinguishable from lespedezas when in flower or fruit, the two genera may be confused in the vegetative state. Stipels are absent in lespedezas, but tickclovers have a pair at the base of the terminal leaflet and a single stipel at the base of each lateral leaflet.

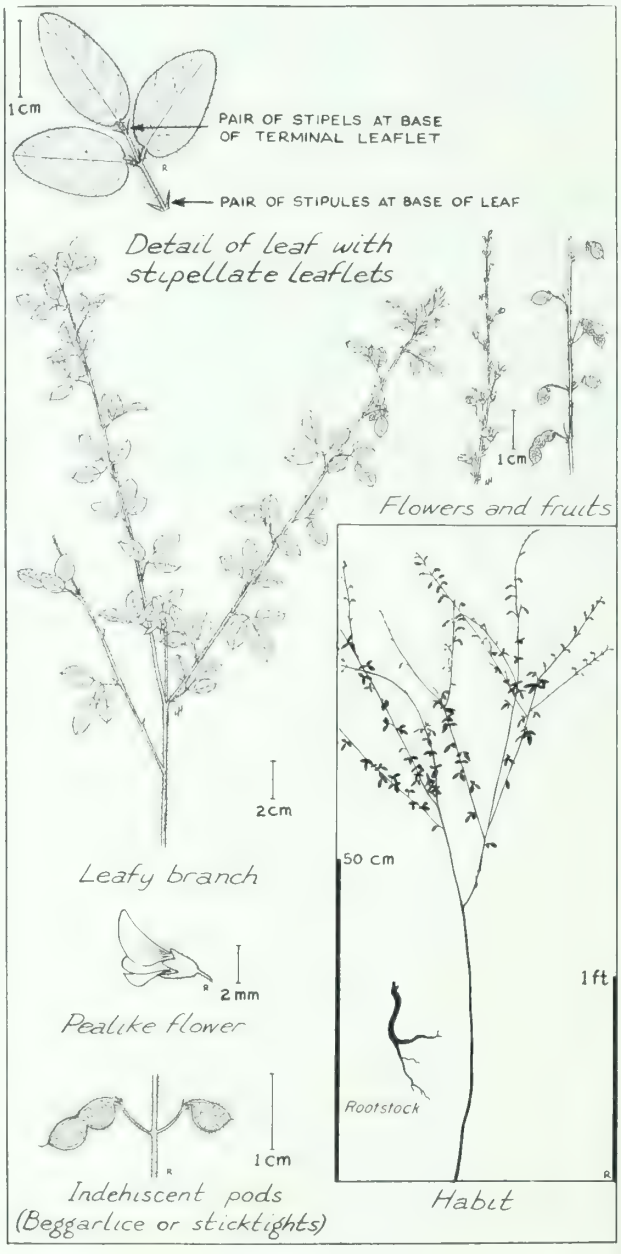
Although littleleaf and rigid tickclovers are nutritious and palatable, the plants are seldom abundant enough to yield much forage. Seeds of both species are valuable quail food.

Range: Texas to Florida, north to Nebraska and Michigan.

Perennial. **Plants** erect or ascending, 60-100 cm. tall, branching from a thick root; **stems** slender, subangulate, usually spreading-pilose with long slender trichomes intermixed with short ones in lines alternating with glabrous strips; **leaves** trifoliolate, stipules linear-subulate, 2-4 mm. long, quickly deciduous; **leaflets** small, ovate to orbicular, pilose, terminal leaflet 1-3 cm. long; **stipels** apiculate; **flowers** papilionaceous, small, rose purple, in large terminal racemes; **fruit** a loment with one to three articles 4-5.5 mm. long, 2.7-4 mm. wide, covered with short, stout hooks.



Rigid tickclover



Littleleaf tickclover

NUTTALL WILDINDIGO

Baptisia nuttalliana Small

Nuttall wildindigo is a bushy, herbaceous perennial growing from large woody rootstocks. It is most common in south-central Louisiana and southeastern Texas. Mature plants are usually 2 to 3 feet tall. On dry sites that are heavily grazed and frequently burned, wildindigo is often an abundant understory plant. It seldom occurs on open cutover sites, probably because of grass competition.

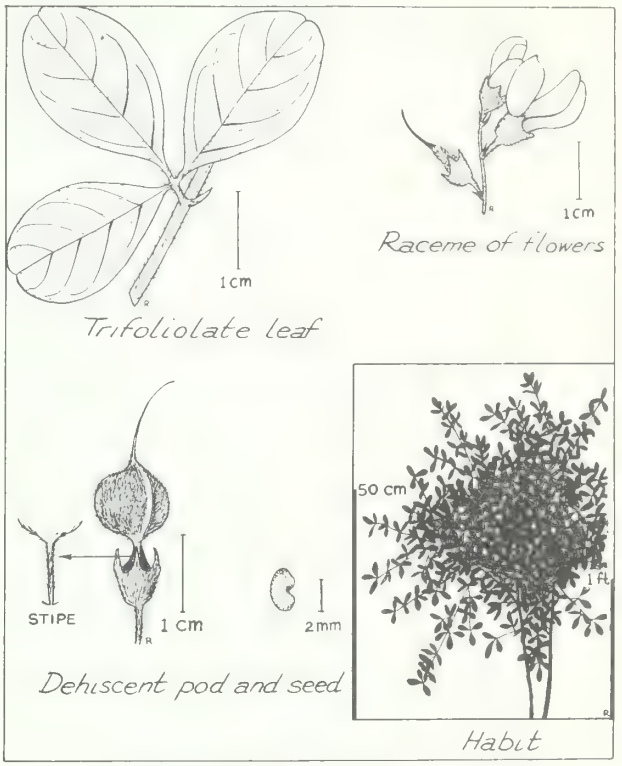
New growth emerges in late winter while most other forbs are dormant. Plants bloom in the spring and mature in early summer, turning blue black (indigo) at maturity. Pale yellow flowers are in terminal racemes or solitary in leaf axils; commonly, these arrangements are mixed. Leaves are trifoliolate with oblanceolate or elliptical leaflets 1 to 3 inches long.

Several other wildindigos occur in the South. Most are low-growing plants that are not easily confused with the taller *B. nuttalliana*. Commonest among these is whitestem wildindigo, *B. laevicaulis* (Gray) Small. Its branches end in large clusters of yellow flowers. These showy inflorescences droop, often touching the ground. Bracts at the base of flower pedicels are prominent; these are inconspicuous or absent in Nuttall wildindigo.

Some species of *Baptisia* are reportedly poisonous to livestock. Nuttall wildindigo is suspect but cattle seldom eat it, even on heavily grazed range.

Range: East Texas, Louisiana, Arkansas, and western Mississippi.

Perennial. **Stems** 0.4-1 m. tall, much branched from thick rhizomes; **leaves** trifoliolate, stipulate; **leaflets** 2-6 cm. long, cuneate to obovate-cuneate, rounded or notched at the apex, glossy above, dull beneath, with scattered pubescence; **flowers** 1-12, papilionaceous, at the tips of leafy branches; **calyx** 8-10 mm. long, campanulate, silky pubescent; **corolla** pale yellow; **keel** 15 mm. long; **standard** with reniform blade 1.2-1.8 cm. broad; **legume** pubescent, subglobose, long-stipitate, thick-walled and woody with a long, slender beak (style), the body 1-1.7 cm. long; **seeds** many, 2.5 mm. long, bean shaped, yellow brown, smooth.



Nuttall wildindigo

COMPOSITES

The composites or Compositae, with about 20,000 species worldwide, are the largest plant family. By comparison, grasses number about 6,000 and legumes 14,000.

The composites are well known for their showy flowers. Chrysanthemums, asters, daisies, and zinnias are among the popular ornamentals. Many native composites—sunflowers, goldenrods, and coneflowers, for example—are also colorful.

On longleaf pine-bluestem range, composites contribute up to 3 percent of the yearlong diet of cattle. While several species are valuable as forage, many are worthless. A few species, such as bitter sneezeweed, are poisonous.

Although composites are mainly herbaceous, the family has several woody species. These are represented in the South by the shrubby genus *Baccharis*.

The characteristic composite "flower" is actually a compact head of small, sessile flowers crowded on a common receptacle and surrounded by overlapping bracts. The corollas are of two general types: the five-petaled tubular type, or disk flower; and the flat, ligulate type, or ray flower. Singly, or in combination, disk and ray flowers produce three types of heads: the discoid, represented by the gayfeathers; the ligulate, such as the dandelions; and the radiate, or coneflower head.

Composites are prolific seeders, and the seeds of many are easily transported by the wind. Hence, these plants are generally more abundant than other forbs, especially on denuded sites where seeds easily reach mineral soil.

Key to composites

1 HEADS COMPOSED OF DISK FLOWERS ONLY; pappus of many slender bristles

2 Inflorescence simple, unbranched, a spike or raceme

Liatris spp., gayfeathers →

2 Inflorescence compound, a large, well branched corymb or panicle

Eupatorium spp., → eupatoriums

1 HEADS COMPOSED OF BOTH DISK AND RAY FLOWERS; pappus of bristles or scales, or wanting

3 Receptacle naked

4 Pappus of 6 or 7 awned scales

Helenium amarum, → bitter sneezeweed

4 Pappus of bristles

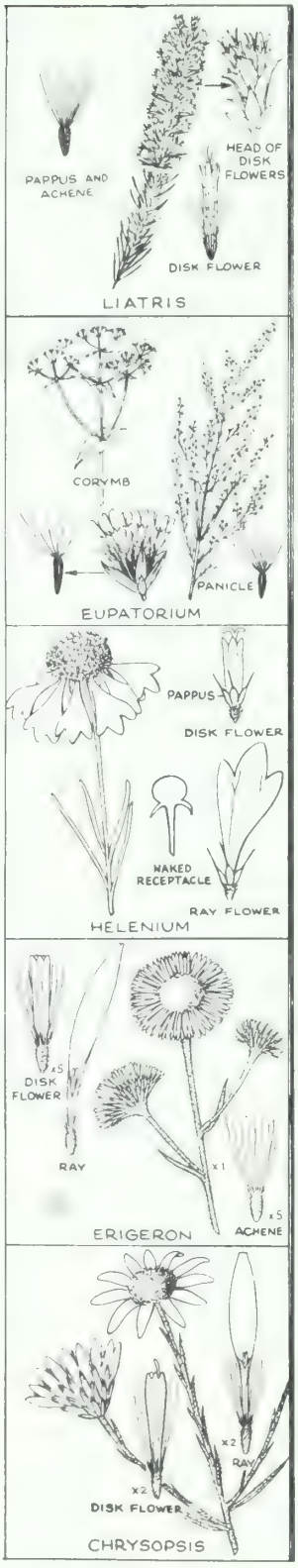
5 Rays numerous, white or pink (in our species); annuals flowering in spring

Erigeron strigosus, → daisy fleabane

5 Rays few, yellow; perennials flowering in summer and fall

6 Heads 2 cm. broad, solitary at the ends of branches

Chrysopsis graminifolia, → grassleaf goldaster



6 Heads rather small, less than 1 cm. broad, crowded compactly on the branches of terminal spikes or panicles

Solidago spp., goldenrods →

3 Receptacle chaffy

7 Disk flowers light colored (golden yellow); involucral bracts of two distinct forms in two separate sets or whorls

Coreopsis lanceolata, → thickleaf coreopsis

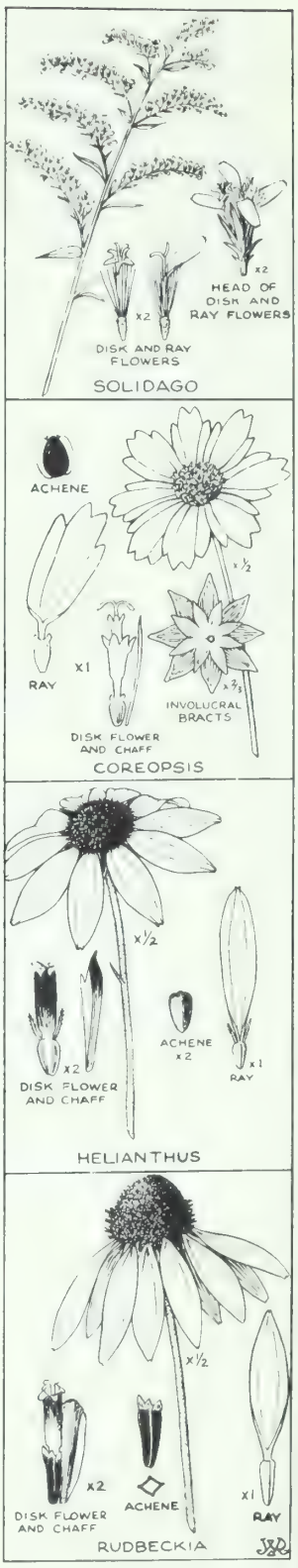
7 Disk flowers dark (purple brown or black); involucral bracts more or less alike, not in two dissimilar whorls

8 Receptacle slightly convex; ray flowers bright yellow orange, mostly spreading

Helianthus angustifolius, → swamp sunflower

8 Receptacle broadly cone shaped or subglobose; ray flowers light lemon yellow, drooping

Rudbeckia alismaefolia, → plantainleaf coneflower



Eupatoriums

Eupatorium spp.

The eupatoriums are some of the most common forbs in the South. Several species grow on longleaf pine-bluestem range in good to excellent condition; others occur only as invaders of severely disturbed sites. In general, eupatoriums have little grazing value. The seeds of several are eaten by birds. At least one species—white snakeroot, *E. rugosum* Houtt.—is poisonous to livestock.

The profusely branched inflorescence is composed of many heads in flat-topped, rounded, or conical arrangements. In all species common on longleaf pine-bluestem range, flowers are tubular, white, and about ¼ inch long. Heads are enclosed at the base by a whorl of greenish bracts, which in some species have whitish margins and tips. Most eupatoriums have fewer than 10 flowers per head, but some have up to 70. Each corolla is surrounded and almost hidden by an early developing ring of hairs, or pappus, which acts as a parachute to aid in wind dissemination of the seed.

Eupatoriums flower in late summer and fall; hence recognition during most of the growing season must depend on vegetative differences. The following key is for identification by foliage characteristics. All plants are perennials. Detailed descriptions of four principal species follow the key.

Key to eupatoriums

1. Leaves dissected into narrow segments, opposite and alternate on same plant; inflorescence conical
   2. Leaf segments hairlike; plant tops lax, slightly drooping ..... *E. capillifolium* (Lam.) Small, dogfennel
   2. Leaf segments flat, often ⅛-¼ inch wide; plant tops erect ..... *E. compositifolium* Walt., yankeeweed
1. Leaf margins toothed but not dissected, opposite; inflorescence more or less flat-topped
   3. Length of leaf blade less than twice the width; blades ovate
      4. Blades somewhat longer than wide; base of blade rounded or narrowing toward point of attachment
         5. Blades attached to main stem, no leaf stalk ..... *E. pubescens* Muhl., hairy eupatorium
         5. Blades with obvious leaf stalks, rather thin ..... *E. rugosum* Houtt., white snakeroot
      4. Blade about as long as wide; base of blade straight and perpendicular to midvein, or heart-like ..... *E. rotundifolium* L., roundleaf eupatorium
   3. Length of blade more than twice the width, lance shaped or linear
      6. Blades averaging over ½ inch wide at broadest point
         7. Blades broadest at base, lance shaped, bases of opposite leaves joining around stem ..... *E. perfoliatum* L., boneset
         7. Blades broadest in middle, tapering toward both ends, opposite leaves not joined
            8. Blade margins toothed only from middle outward, margins of lower half entire ..... *E. cuneifolium* Willd. var. *semiserratum* (DC.) Fern. & Grisc., smallflower eupatorium
            8. Blade margins completely toothed ..... *E. album* L., white eupatorium
      6. Blades averaging less than ½ inch wide, about six times as long as broad
         9. Leaves opposite with reduced axillary branches, giving appearance of dense whorls ..... *E. hyssopifolium* L., hyssopleaf eupatorium
         9. Leaves obviously opposite, no axillary branches ..... *E. leucolepis* (DC.) T. & G., hoarscale eupatorium

DOGFENNEL

Eupatorium capillifolium (Lam.) Small

Dogfennel, and its close relative yankeeweed, *E. compositifolium* Walt., invade abandoned fields, overgrazed pastures and rangeland, and roadsides, especially on dry, sandy soils. Dogfennel grows in colonies from a thick, woody, underground base. Plants average 4 to 5 feet in height, but on moist fertile sites they may reach 9 feet. On dry, sandy soils, yankeeweed is usually the more abundant.

Dogfennel leaves are deeply dissected into fine, hairlike lobes, that give the foliage a needlelike appearance. Yankeeweed leaves are also divided, but segments are broader.

The dogfennel inflorescence is a long, conical panicle, usually somewhat lax or nodding. Only yankeeweed has a similar inflorescence, that of other eupatoriums being flat-topped. Dogfennel and yankeeweed flower in the fall, later than most associated plants. They emit a pleasing fragrance when in full bloom.

Dogfennel is scarce on rangelands in good condition. It has no value as forage or wildlife food. Cattle graze it sparingly, if at all, even where other herbage is scarce.

Range: Texas to Florida, north to Tennessee and New Jersey.

Perennial. **Stems** 1-3 m. tall, pubescent or puberulent, several from a stout woody caudex, upper stem lax, nodding; **leaves** pinnately dissected into filiform divisions, 2-10 cm. long, glabrous, glandular-punctate, often with axillary fascicles; **inflorescence** a lax, elongate, conical panicle; **heads** three to five flowered, 3-5 mm. long; **flowers** 2-3 mm. long; **corolla** white, tubular; **achene** 1 mm. long, smooth.

HYSSOPLEAF EUPATORIUM

Eupatorium hyssopifolium L.

This eupatorium grows on drainageways and poorly drained flats throughout the longleaf pine type. Although rarely abundant, plants are conspicuous when flowering in late summer.

Mature plants may reach 3 feet in height, but average about 2 feet. Primary leaves are about 1½ inches long and ½ inch or less in width. Their sparsely toothed, or entire, margins frequently roll inward along the lower surface; thus, blades may appear threadlike, resembling those of dogfennel. Hyssopleaf eupatorium is distinguishable by the reduced leafy branches arising from leaf axils. These branches cause leaves, which are generally paired and opposite, to appear numerous and whorled. In some specimens, however, three or four leaves may occur at each node.

Leaves of hoarscale eupatorium, *E. leucolepis* (DC.) T. & G., are narrow like those of hyssopleaf eupatorium, and the two species inhabit similar sites. But because hoarscale eupatorium is without branches in the leaf axils, its leaves appear distinctly opposite.

Cattle rarely graze either eupatorium.

Range: Texas to Florida, north to Rhode Island.

Perennial. **Stems** 30-100 cm. tall, puberulent or strigose; **leaves** simple, linear, 1-10 mm. wide, 2-6 cm. long, opposite or sometimes three to four verticillate, appearing whorled because of axillary leafy branches, upper leaves often alternate, margins entire or few-toothed; **inflorescence** a corymb, 8-20 cm. wide; **heads** 6-9 mm. long; **bracts** 4-7 mm. long, canescent-pilose, scarious-margined; **corolla** white, exceeding bracts, 3-4 mm. long; achene 2 mm. long, ribbed.

ROUNDLEAF EUPATORIUM

Eupatorium rotundifolium L.

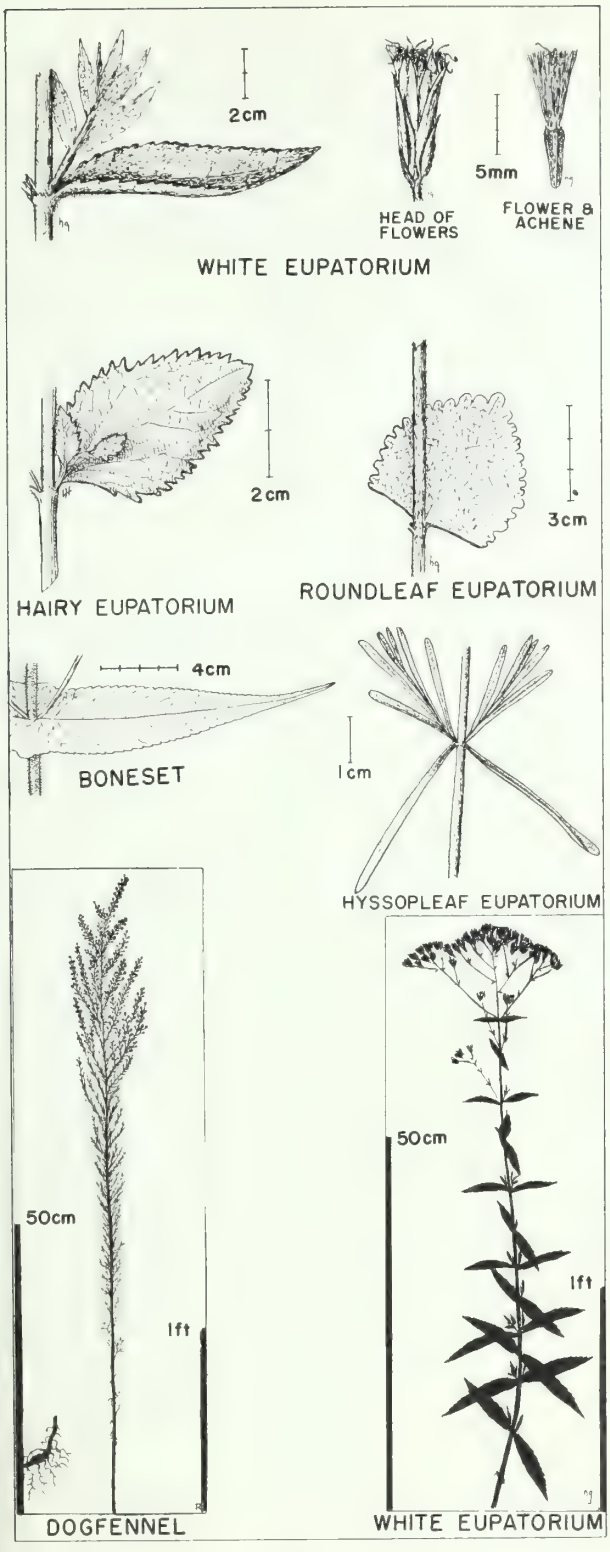
Roundleaf eupatorium is common on poorly drained uplands. It grows as scattered individuals about 2 feet tall. Leaves are ovate with regular, blunt teeth. Leaf blades, attached directly to the stem, average 1 inch long and 1 inch wide.

Hairy eupatorium, *E. pubescens* Muhl., closely resembles roundleaf eupatorium, grows on similar sites, and is sometimes considered only a variety of roundleaf. The two are taxonomically close and probably intergrade. Despite its name, hairy eupatorium is not noticeably hairier than roundleaf, and the only obvious difference is in leaf shape. Leaf bases of hairy eupatorium are tapered or rounded toward the point of attachment, not straight and perpendicular to the midribs as in roundleaf. Leaves also are distinctly longer than wide. Neither species has a measurable leafstalk.

Both roundleaf and hairy eupatorium are unpalatable to cattle.

Range: Texas to Florida, north to Tennessee and New York.

Perennial. **Stems** 30-120 cm. tall, tomentulose; **leaves** simple, opposite, sessile, ovate to subrotund, crenate or crenate-dentate, with straight, entire, subtruncate, cordate to broadly cuneate bases, scabrous above, pilose and rugose-veiny beneath, 2-7 cm. long, width approximately equaling length; **corymb** 10-20 cm. wide; **heads** 5-7 mm. long; inner **bracts** pilose, white-scarious-margined, 3-5 mm. long; **corolla** white, tubular; **achene** 2-3 mm. long.



Eupatorium species

WHITE EUPATORIUM

Eupatorium album L.

White eupatorium, so named because of the whitish membranous margins of the bracts surrounding the flower heads, is common on well-drained sandy soils. It is abundant on range that is periodically burned.

Mature plants are about 2 feet tall and conspicuously hairy. The leaves are opposite, elliptical, coarse-toothed, and without petioles. Blades may be up to 5 inches long and 1 inch wide, but they are commonly about 2 inches long and ½ inch wide. Flat-topped inflorescences appear in midsummer and flowering continues until frost.

Although boneset, *E. perfoliatum* L., and smallflower eupatorium, *E. cuneifolium* Willd. var. *semiserratum* (DC.) Fern. & Grisc., resemble white eupatorium slightly, they are usually confined to wetter sites. Other differences are noted in the key.

Cattle occasionally graze the tender spring leaves of white eupatorium, but the coarse, stiff foliage of older growth is unpalatable.

Range: Louisiana to Florida, north to Arkansas, Ohio, and New York.

Perennial. **Stems** 20-90 cm. tall, harshly pubescent; **leaves** simple, opposite, glandular-punctate, elliptic to lanceolate, serrate, sessile, pilose to scabrous or almost glabrous, 3-10 cm. long, 1-3 cm. wide; **inflorescence** a corymb 10-25 cm. broad, ultimate branchlets terminated by a head of three to five tubular flowers; **heads** 8-11 mm. long; **bracts** imbricate, lanceolate, white-scarious-margined, glandular-punctate, exceeding the corolla; **corolla** white, tubular, glandular-punctate, 3-5 mm. long; **fruit** an achene, 3-5 mm. long.

Gayfeathers

Liatris spp.

Three species of gayfeather, or blazing star, commonly grow on longleaf pine-bluestem range. All are slender, erect, narrow-leaved perennials, with stems from a bulblike base. Rose-purple flowers appear from midsummer until fall. The inflorescence, though conspicuously spikelike, is actually an elongated cluster of flower heads.

The gayfeathers inhabit open to moderately timbered sites. All grow best on dry, sandy soils. Cattle may eat new growth but generally reject older herbage. Gayfeathers are moderately resistant to grazing, but dwindle rapidly on heavily used areas. Thus, an abundance of gayfeathers indicates that the range is not being overgrazed.

KANSAS GAYFEATHER

Liatris pycnostachya Michx.

This is the largest common gayfeather of longleaf pine-bluestem range. Plants may reach almost 6 feet in height. They grow mainly on well-drained sandy soils in forest openings.

Plants are hairy throughout. Lower leaves, up to a foot long and ⅜ inch wide, generally droop. Leaf size gradually diminishes up the stem, the smaller, upper leaves pointing stiffly skyward.

The dense, spikelike inflorescences are 6 inches to a foot long. Heads are about ⅜ inch long, with 5 to 12 flowers per head. Floral bracts are numerous; their tips, which curl away from the head, are purple-tinged.

Cattle graze Kansas gayfeather sparingly. Deer eat spring and summer foliage.

Range: Texas and Oklahoma to South Dakota and Minnesota

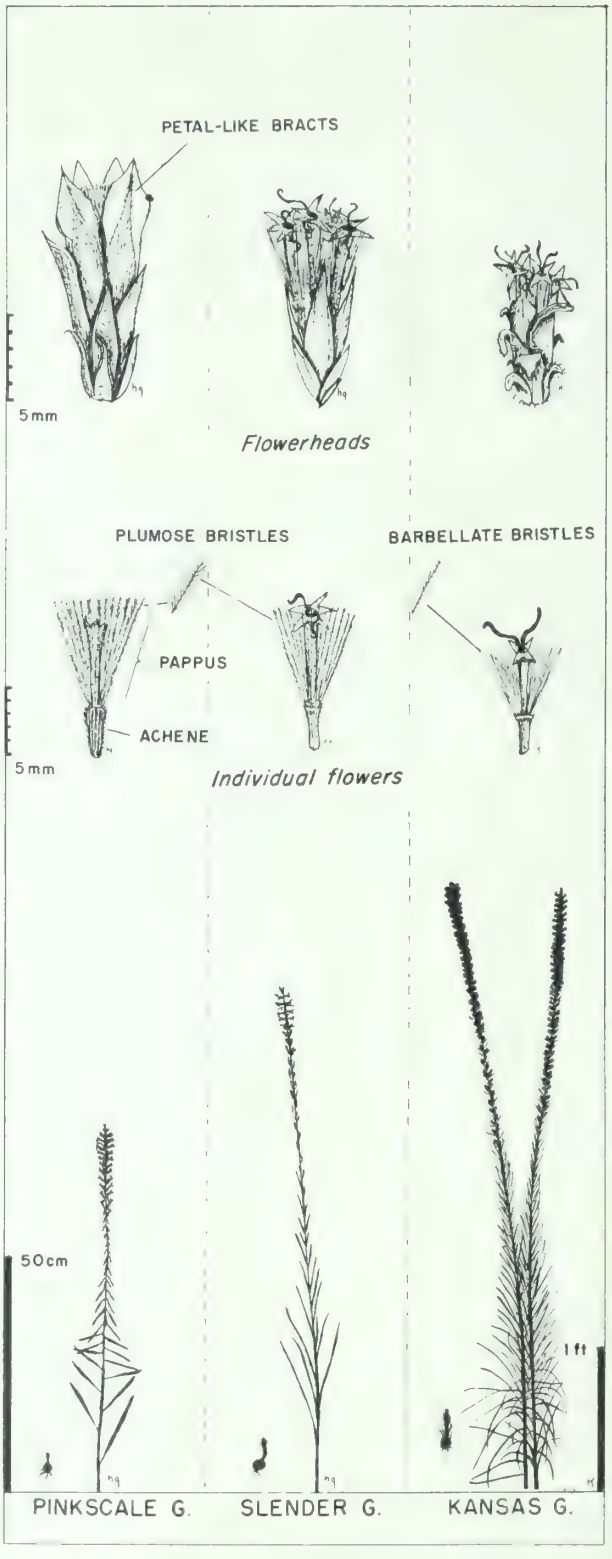
Perennial. Stems several, 60-120 cm. tall, stiff, hirsute, from corm; leaves 10-30 cm. long, alternate, 4-10 mm. wide below, mostly ascending, much reduced above, pubescent, punctate; inflorescence 15-30 cm. long, about 2 cm. wide, cylindrical, spikelike; heads 5-12 flowered, about 1 cm. long, cylindrical, sessile; flowers 10-11 mm. long, rose magenta; involucral bracts in several series, green or purplish, pubescent, lanceolate-acuminate, the acute tips squarrose, reflexed or spreading; achenes 4-6 mm. long, ribbed, pubescent; pappus with barbellate bristles.

PINKSCALE GAYFEATHER

Liatris elegans (Walt.) Michx.

This attractive gayfeather usually grows 2 to 3 feet tall. It flowers in late summer or fall, providing color after other gayfeathers have matured.

Lower leaves are generally less than 6 inches long and up to ⅜ inch wide. Leaf size gradually



Gayfeathers

diminishes up the stalk. The upper leaves of pinkscale point downward at about 45°, thus differing from those of Kansas and slender gayfeather.

The inflorescence is 4 to 6 inches long and about 1 inch in diameter. Color is provided mostly by the long, rose-purple tips of the floral bracts. These extend beyond the flowers, obscuring the petals. The inflorescence is less densely flowered than that of Kansas gayfeather, but denser than in slender gayfeather. Floral bracts (except the tips) and stems are loosely coated with short, stiff, white hairs.

Although cattle may occasionally graze young growth, pinkscale gayfeather is not a valuable forage plant. Deer eat the foliage in spring and summer.

Range: Texas to Florida and southern Virginia.

Perennial. **Stems** 30-100 cm. tall, pubescent, leafy, unbranched, from corm; **leaves** linear-spatulate to lanceolate, alternate, sessile, punctate, acute; **basal leaves** ascending, to 12 cm. long and 7 mm. wide; **upper leaves** decurrent, diminishing in length to 1 cm. among the heads; **inflorescence** 10-40 cm. long, 3-6 cm. broad, cylindrical, spikelike, with many elongate sessile heads, or pedicellate heads on short, branched peduncles; **heads** slender, 1.5-2.5 cm. long; **tubular flowers,** white to lavender, three to five per head, 9-11 mm. long; **involucral bracts** in several series, the outer green, punctate, pubescent, various lengths; the inner 10-18 mm. long, 2-3 mm. wide, green, punctate and pubescent below, with rose-magenta to white, serrulate, petaloid tips; **achenes** 4-6 mm. long, cylindrical, pointed, ribbed, pubescent; **pappus** long-plumose, 9-11 mm. long.

SLENDER GAYFEATHER

Liatris acidota Engelm. & Gray

Slender gayfeather grows mainly on dry, open sites. Plants are usually most abundant on sandy ridges and on pimple mounds in areas that are otherwise wet.

Stems grow about 2 feet tall from bulblike corms. Leaves are gray green and hairless, and 1/16 to ⅛ inch wide. Lower leaves are up to 8 inches long, but at about 6 inches above the ground, leaf length abruptly diminishes to about 1 inch. The uppermost leaves are even shorter—less than ¼ inch long.

Flower heads, averaging ½ inch long and short-stalked, are spaced about ¼ inch apart. Rose-purple flowers, two to four per head, are surrounded by a loose whorl of stiff, sharp-pointed bracts. The bracts are green at first, turning dark purple at flowering. They vary in length, but the longest are shorter than the flowers. The inflorescence comprises about 1/3 of the plant height. Heads at the summit begin maturing in midsummer; flowering continues downward, with the lowermost heads maturing last.

Young plants are occasionally grazed by cattle, but older herbage is rejected unless better forage is scarce.

Range: Texas and Louisiana to Kansas and Arkansas.

Perennial. **Stems** glabrous, 30-70 cm. tall, from corms; **leaves** linear, alternate, the lower 1-3 mm. wide, 10-18 cm. long, the upper less than 1 mm. wide and 2 cm. long, ascending, glabrous but obscurely white-scurfy; **inflorescence** slender, spikelike, 10-25 cm. long; **heads** sparse, 1 cm. long, three to five flowered; **bracts** of mature flowers few, the inner 6-7 mm. long, purple, stiff, acuminate, not scarious-margined nor petaloid; **flowers,** including the mature achene, 10 mm. long, exceeding the bracts; **corolla** equaling the plumose **pappus,** rose-magenta, individual flowers 10 mm. long including mature **achene.**

PLANTAINLEAF CONEFLOWER

Rudbeckia grandiflora (Sweet) DC., var. *alismaefolia* (T. & G.) Cronq.

Plantainleaf coneflower, a perennial with thick, fleshy rootstocks, is common on well-drained uplands. Mature plants are 16 inches to more than 3½ feet in height.

Foliage is useful in identifying the species before flowering. Basal leaves, with their broadly elliptical to egg-shaped blades and long petioles, are distinctly paddlelike, and resemble leaves of waterplantain (*Alisma* spp.). In large specimens, petioles may reach 10 inches, with blades 5 inches long and 2 inches wide. Leaf size diminishes up the stem. Blade margins are sparingly toothed or wavy. Often the upper half of the plant is leafless.

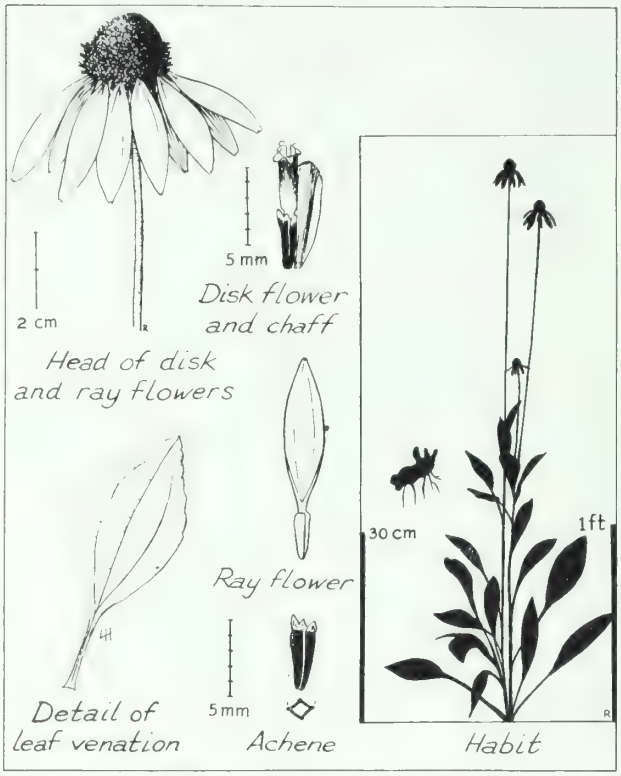
The name "coneflower" refers to the prominent, cone-shaped central disk of brownish-purple flowers. Cones average ¾ inch in diameter. Yellow ray flowers, 10 to 15 per head and an inch long or more, droop from the base of the cone. They fall when the head is mature, leaving the persistent cone and its subtending bracts.

Another common coneflower is black-eyed-susan, *R. hirta* L. It is distinguishable from plantainleaf coneflower by its basal leaves, which are usually 2 to 3 inches long, and lance shaped.

Cattle occasionally graze early leaves of plantainleaf coneflower. Deer eat young leaves and stems, and quail and doves feed on the seeds.

Range: East Texas to central Arkansas and Louisiana.

Perennial. **Stems** 50-90 cm. tall, from woody rhizome, usually simple, slender, glabrous to slightly scabrous above; **basal leaves** long-petioled, the blade 5-12 cm. long, three to five ribbed, scabrous, punctate; **uppermost leaves** similar, but smaller and sessile, alternate; **heads** 3-5 cm. broad (rays reflexed), radiate, solitary on elongate, leafless peduncles; **involucral bracts** linear, reflexed, scabrous; **disks** 1.5-2 cm. broad, dark brownish purple, subglobose; **disk flowers** on a conical, chaffy receptacle; 8-9 mm. long, fertile, dull purple-black tipped, petals reflexed, stigmas bright yellow; **chaff** 4-5 mm. long, enclosing the disk flower; **rays** 10-15, 3-4 cm. long, neuter, yellow; **achene** 5 mm. long, four-angled; **pappus** a crown of uneven, deltoid teeth.



Plantainleaf coneflower

THICKLEAF COREOPSIS

Coreopsis lanceolata L. var. *villosa* Michx.

Thickleaf coreopsis grows on widely varying sites. Though rarely abundant, plants are conspicuous by their naked flower stalks and bright yellow flowers.

Mature stems are usually less than 15 inches tall. Stems and leaves are generally covered with downy to stiff hairs. Leaves are opposite, narrow to broadly lance shaped, and largely confined to the lower half of the stalk. Early leaves form a basal rosette; with their long, slender petioles, they often exceed 6 inches in length. Upper leaves are without petioles and are distinctly smaller than the lower.

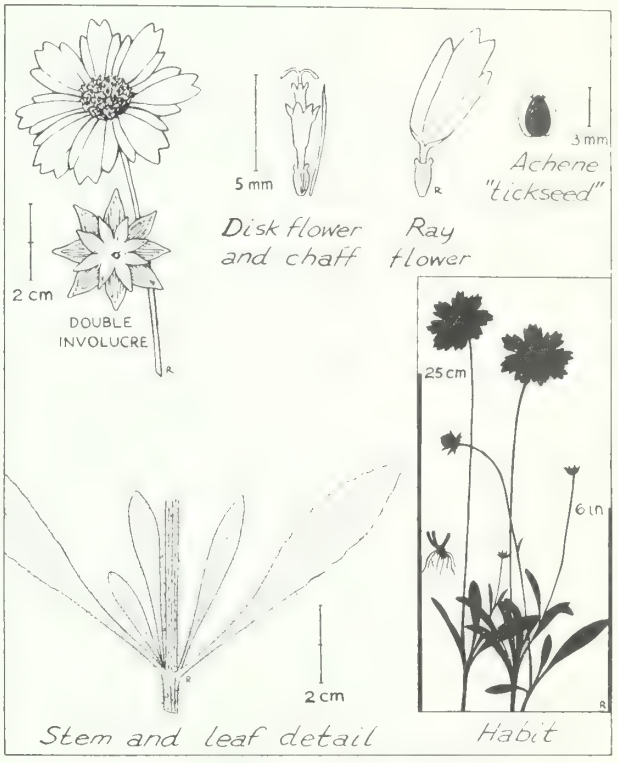
Flowering begins in April and continues through the growing season. Heads have yellow tube and ray flowers, and are about 2 inches in diameter. The toothed ray flowers are about ¾ inch long.

Immature plants of lanceleaf gaillardia, *Gaillardia aestivalis* (Walt.) H.F.L. Rock, resemble those of thickleaf coreopsis but are distinguishable by their alternate leaves. After flowers appear, differentiation is easy, as the disks of lanceleaf gaillardia are red violet.

Thickleaf coreopsis is of little value to livestock or game animals.

Range: Louisiana to Florida, north to Missouri, Illinois, and Virginia.

Perennial. **Stems** 20-60 cm. tall, from a woody caudex, branching near the base, glabrous, pubescent or villous; **leaves** mostly basal and petiolate, 5-20 cm. long, 10-17 mm. wide, lance-linear to spatulate, entire, opposite, glabrous to villous; **heads** 4-6 cm. broad, radiate, solitary on elongate, naked peduncles; **involucre** double, the outer bracts linear-lanceolate, 6-8 mm. long, the inner ovate, 0.8-1.3 cm. long; **disks** 1-2 cm. broad, deep yellow orange, slightly convex; **disk flowers** on a flat, chaffy receptacle, 5-7 mm. long, fertile; **rays** eight, 15-30 mm. long, 5-10 mm. wide, cuneate to obovate, deeply four-toothed, brilliant yellow, sterile; **achenes** 2.5-3 mm. long, compressed, orbicular, with thin, flat wings; **pappus** of two minute, chaffy teeth.



Thickleaf coreopsis

DAISY FLEABANE

Erigeron strigosus Muhl. var. *beyrichii* (Fisch. & Mey.) T. & G.

Like most annual composites, daisy fleabane is most abundant on old fields, roadsides, firelines, and other open, disturbed areas. It is often common under moderately dense timber. Sandy soils apparently provide the best habitat.

Plants may reach a height of 3 feet or more where competition is light, but where grass is dense, height seldom exceeds 2 feet. Early spring leaves, which form a rosette on the lower stem, are coarsely toothed. They are 6 inches long and 1 inch wide, with the greatest width in the upper one-third. Leaves on the upper stem are smaller—1 to 3 inches long and less than ½ inch wide—and without toothed margins. Leaves and stems are sparsely covered with short, stiff, ascending hairs that make plants rough to the touch.

The inflorescence consists of several to many daisylike flower heads, ⅝ inch or less in diameter. Each head has an outer ring of ray flowers and an inner disk of tubular flowers. The ligules of the ray flowers are about ¼ inch long and usually white, though occasionally the outer may be bluish or pink. Yellow flowers make up the central disk, which is about ⅜ inch in diameter. Flowering may begin in mid-April and continue through midsummer. Both ray and disk flowers produce a two-nerved achene less than 1/16 inch long.

Cattle graze daisy fleabane in the spring before flowers form. On some sites, plants are abundant enough to contribute considerable forage. Nutritive value of young plants is high. In summer, deer may browse the flowers and upper stems.

Range: Texas to Florida, north to Rhode Island and west to Washington.

Annual. **Stems** strigose, 20-100 cm. tall; **basal leaves** oblanceolate to elliptic, entire or toothed, petiolate, up to 15 cm. long and 2.5 cm. wide; **upper leaves** linear to lanceolate, minutely strigose to glabrous, entire, alternate, sessile; **inflorescence** corymbose, of few to many heads; **heads** 5-15 mm. in diameter; **bracts** 2-3 mm. long, linear-lanceolate, scarious margined; **disk** 9 mm. or less in diameter, flowers perfect; **ray flowers** pistillate, rays 6 mm. long or less, white to bluish or pink; **achenes** two nerved, angled, 1 mm. long.

Daisy fleabane

GRASSLEAF GOLDASTER

Chrysopsis graminifolia (Michx.) Ell.

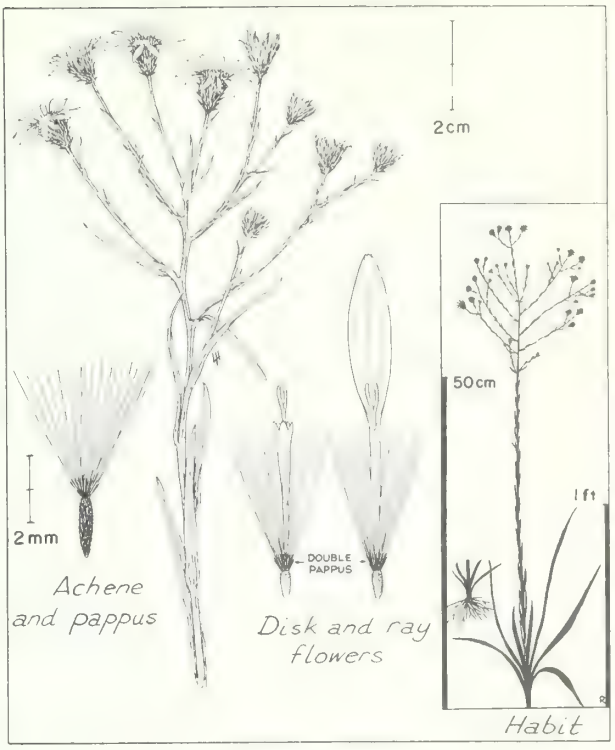
Grassleaf goldaster grows on a variety of sites, but is most common on sandy soils. Until the inflorescences appear in summer, the plants superficially resemble grasses. The elongate leaves measure up to 10 inches, and have prominent longitudinal veins. Long silky hairs paralleling the veins lie flat against the leaf; they produce a silvery sheen, which the dead leaves retain through the winter.

Plants, including the profusely branched inflorescence, grow to 3 feet tall. The asterlike flower heads are about ⅝ inch in diameter, with golden-yellow ray flowers. Several rows of overlapping, narrow bracts enclose the bases.

Because of its scattered distribution, grassleaf goldaster contributes only a small part of the cattle diet. Nutritive value exceeds that of most grasses but palatability is only fair. Cattle graze it mainly in the spring when plants are young and succulent.

Range: Louisiana to Florida and Virginia.

Perennial. **Stems** 30-90 cm. tall; **basal leaves** 10-30 cm long, 0.2-1 cm. broad, veins parallel; **cauline leaves** appressed, alternate, decreasing in size up the stem; **inflorescence** irregularly corymbose; **heads** turbinate, yellow, radiate, solitary at the ends of elongate ascending peduncles; **involucres** 7-11 mm. high; **phyllaries** in several series, loosely white-hairy to glandular; **disk flowers** 7-8 mm. long, numerous, fertile; **ray flowers** fertile, the narrow ligule 8-12 mm. long; **pappus** double; **achene** 3 mm. long, linear, dark brown, hairy.



Grassleaf goldaster

FRAGRANT GOLDENROD

Solidago odora Ait.

Fragrant goldenrod is the most common goldenrod on longleaf pine-bluestem range. It is named for the spicy, aniselike fragrance of the crushed leaves. This character is not dependable, however, as some plants emit little or no odor.

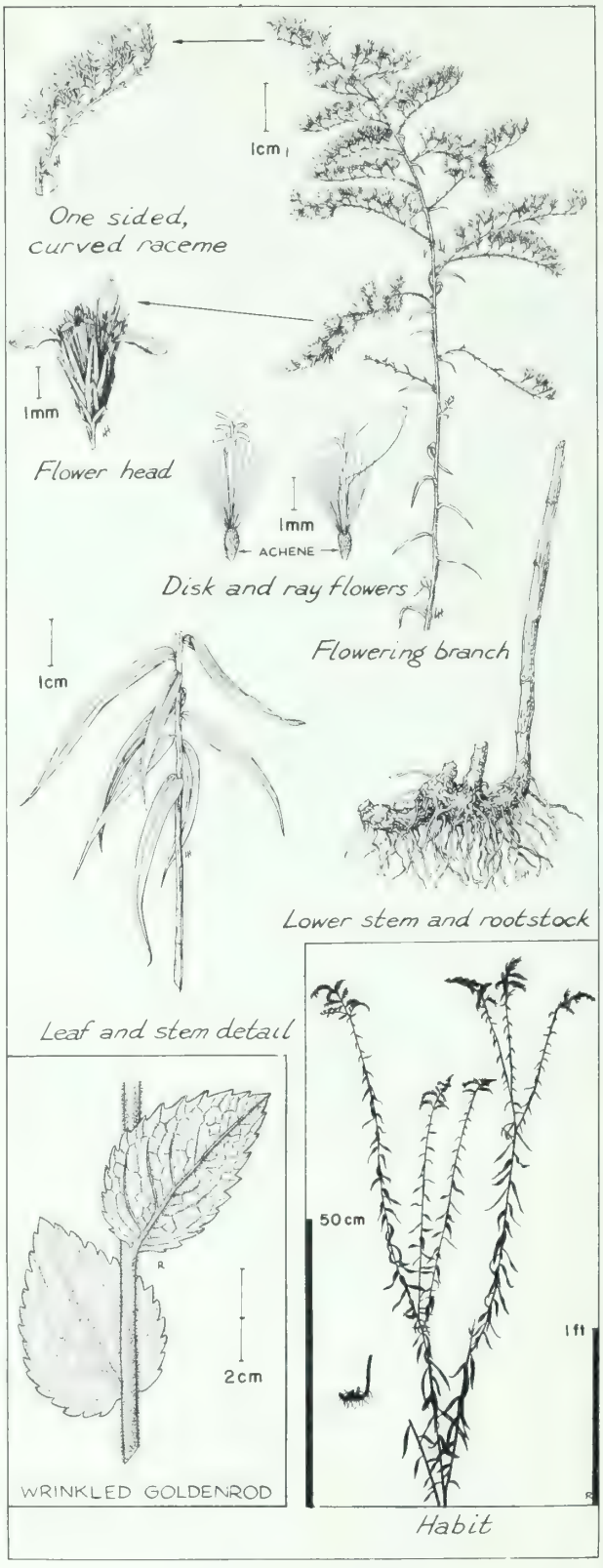
Fragrant goldenrod grows mainly on dry, sandy sites, especially in cutover timberlands, pastures, and abandoned fields. Where competition is light, plants may reach a height of 5 feet. In dense grass, height rarely exceeds 2 feet. Stems, arising from thick rootstocks, are hairless and usually reddish brown. The hairless, lance-shaped leaves are up to 4 inches long and ½ inch wide. They generally point downward, and those of the upper stem are greatly reduced. The heads of golden-yellow flowers are less than ¼ inch long and about 1/16 inch wide.

Also common on longleaf pine-bluestem range is wrinkled goldenrod, *S. rugosa* Ait. Its inflorescence is very similar to that of fragrant goldenrod, but its leaves are ovate and have prominent veins that lend a wrinkled appearance to the blades.

Although cattle occasionally graze young growth, fragrant goldenrod is not a valuable forage plant. Deer eat the immature inflorescences as well as the young shoots. Goldenrods are best known for the suffering they cause in the fall among persons prone to hay fever.

Range: Eastern Texas and eastern Oklahoma to Florida, north to southern Ohio, Vermont, and New Hampshire.

Perennial. **Stems** 50-150 cm. tall, glabrous or pilose in lines; **leaves** simple, alternate, entire or sparsely serrate, glabrous except for ciliolate or scabrous margins, linear-lanceolate, reticulate-veined, 4-16 cm. long, 5-15 mm. wide, gradually reduced up the stem; **inflorescence** variable, but usually a conical panicle of numerous racemes; **racemes** bracteolate; **heads** secund along upper side of raceme, six to eight flowered, 4-4.5 mm. long, **bracts** greenish yellow, 2-3 mm. long; **flowers** with both tubular and ligulate corollas, rays yellow, conspicuous; **achene** setose.



Fragrant goldenrod

SHINY GOLDENROD

Solidago nitida T. & G.

Shiny goldenrod inhabits dry upland sites, both open and timbered. Stems arise from rootstocks to a height of 2 to 2½ feet. The inflorescence, though yellow-flowered and late-blooming, is flat-topped rather than conical, making mature plants easy to distinguish from those of most other goldenrod species. The alternate leaves are similar in texture and venation to those of fragrant goldenrod but much larger. Lower leaves are 4 to 5 inches long, and occasionally 12 inches. The leaves decrease in size up the stem, with those subtending the inflorescence only 1 to 2 inches long. Blades are narrowly lance shaped and entire, except for sparse, obscure teeth on the lower leaves. Width ranges from about ⅜ inch in the lower leaves to 1/16 inch in the uppermost. Thin, almost imperceptible hairs coat the upper stem and inflorescence branches; otherwise, plants are hairless.

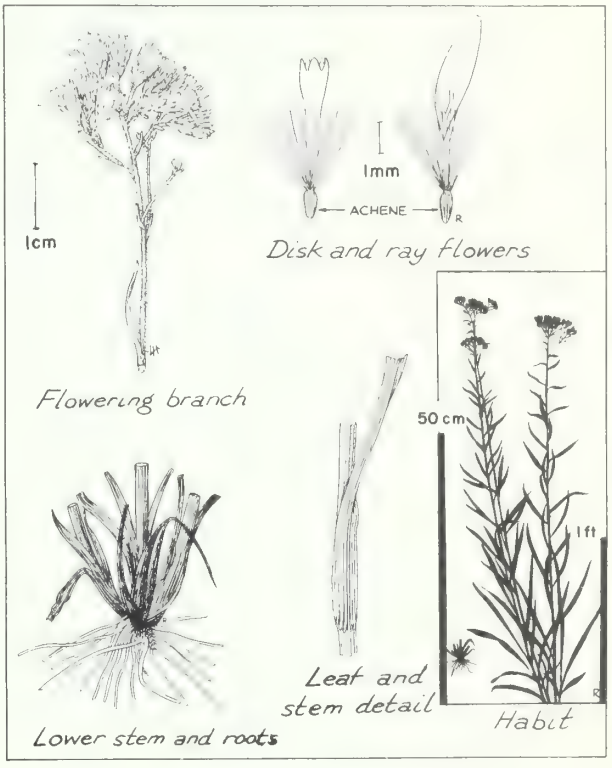
Flower heads, about ¼ inch long, are much larger than those of most goldenrods. Each flower produces an achene about 1/16 inch long.

Slimhead goldenrod, *S. leptocephala* T. & G., is also common on longleaf pine-bluestem range. Like shiny goldenrod, it is practically hairless, with a flat-topped inflorescence and lustrous leaves. Lower leaves are only about half as long as those of shiny goldenrod, and length reduction in upper leaves is less pronounced.

Shiny goldenrod is unimportant as forage, although cattle probably consume some young plants along with grass herbage.

Range: Texas, Oklahoma, and Louisiana.

Perennial. **Stems** 40-90 cm. tall, smooth and glabrous below inflorescence, striate-ribbed; **leaves** numerous, alternate, entire, or obscurely serrate, coriaceous, glabrous and somewhat lustrous, linear or narrowly linear-elliptic, lower leaves 7-30 cm. long and 5-10 mm. wide, gradually reduced up the stem to 3-5 cm. long below inflorescences, 1-2 cm. long in inflorescence branches; **inflorescence** corymbose with finely pubescent branches; **heads** 6-8 mm. long, narrowly campanulate, 7-12 flowered, bracts obtuse, scarious-margined, yellowish; **ray flowers** three to four per head, pistillate, yellow; **disk flowers** perfect, yellowish; **achene** glabrous, 10-ribbed, 1.5 mm. long.



Shiny goldenrod

BITTER SNEEZEWEED

Helenium amarum (Raf.) H.F.L. Rock

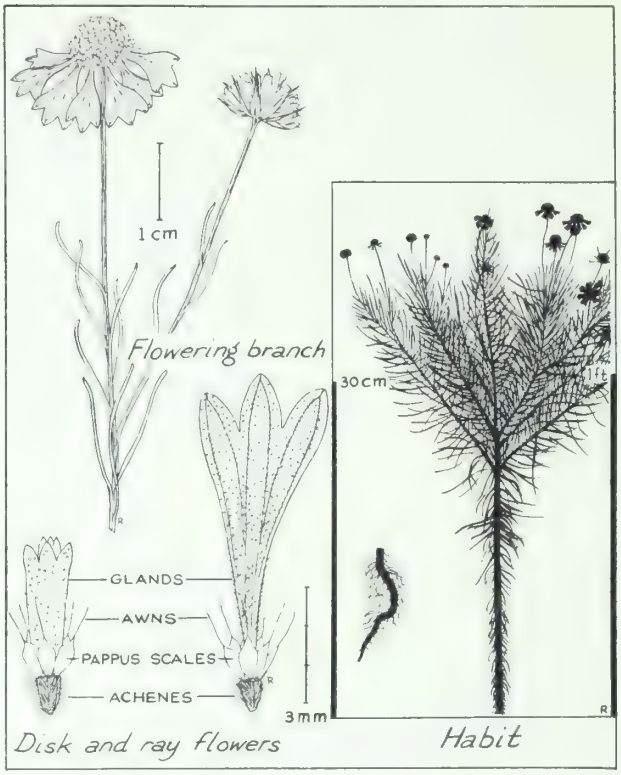
Bitter sneezeweed, like most annuals, is a prolific seeder. It aggressively invades denuded areas, appearing prominently along roadsides, in old fields, and on severely overgrazed grasslands. It tolerates all but very wet or heavily shaded sites.

Height rarely exceeds 2 feet. Stems vary from simple to profusely branched. Leaves are numerous, threadlike, and up to 3 inches long. Each stem or branch produces many flower heads, which average about an inch in diameter. Collectively, these form a flat-topped cluster. The central disk of the head, consisting of tubular flowers, is surrounded by drooping, three-lobed, yellow ray flowers. Flowering begins in the spring and continues through the growing season.

Bitter sneezeweed is low in palatability. Although it is reportedly toxic to livestock, cattle rarely consume enough to develop serious symptoms. When grazed by dairy cows this weed transmits a bitter taste to the milk.

Range: Texas to Florida, north to Kansas, Missouri, Illinois, and Virginia.

Annual. **Stems** 20-50 cm. tall, very leafy, simple to corymbosely branched above the middle; **leaves** 1-8 cm. long, alternate, 1-2 mm. broad, filiform to linear, densely glandular-punctate, glabrous; **heads** several to numerous, 1.5-2.5 cm. broad, radiate, solitary on slender, naked peduncles; disk ocher yellow, globular, 6-12 mm. broad; **disk flowers** 4-5 mm. long, on a globular, naked receptacle; **ray flowers** 5-10, pistillate; **ligules** cadmium yellow, three-toothed, 5-12 mm. long, spreading to reflexed, glandular on the back; **achenes** about 1 mm. long, brown, hairy; **pappus scales** hyaline, with an awn as long as the body.



Bitter sneezeweed

SWAMP SUNFLOWER

Helianthus angustifolius L.

Its name is misleading, for swamp sunflower seldom, if ever, grows in swamps. It is among the most common perennial forbs on a variety of upland range sites, including dry, sandy ridges.

Like most sunflowers, plants are rough throughout. In dense grass, stems seldom exceed 2 or 3 feet in height, the plants usually being inconspicuous until the flower heads appear. In firelanes or other clearings, this species may grow more than 6 feet tall. The lower stem is covered with short, stiff hairs.

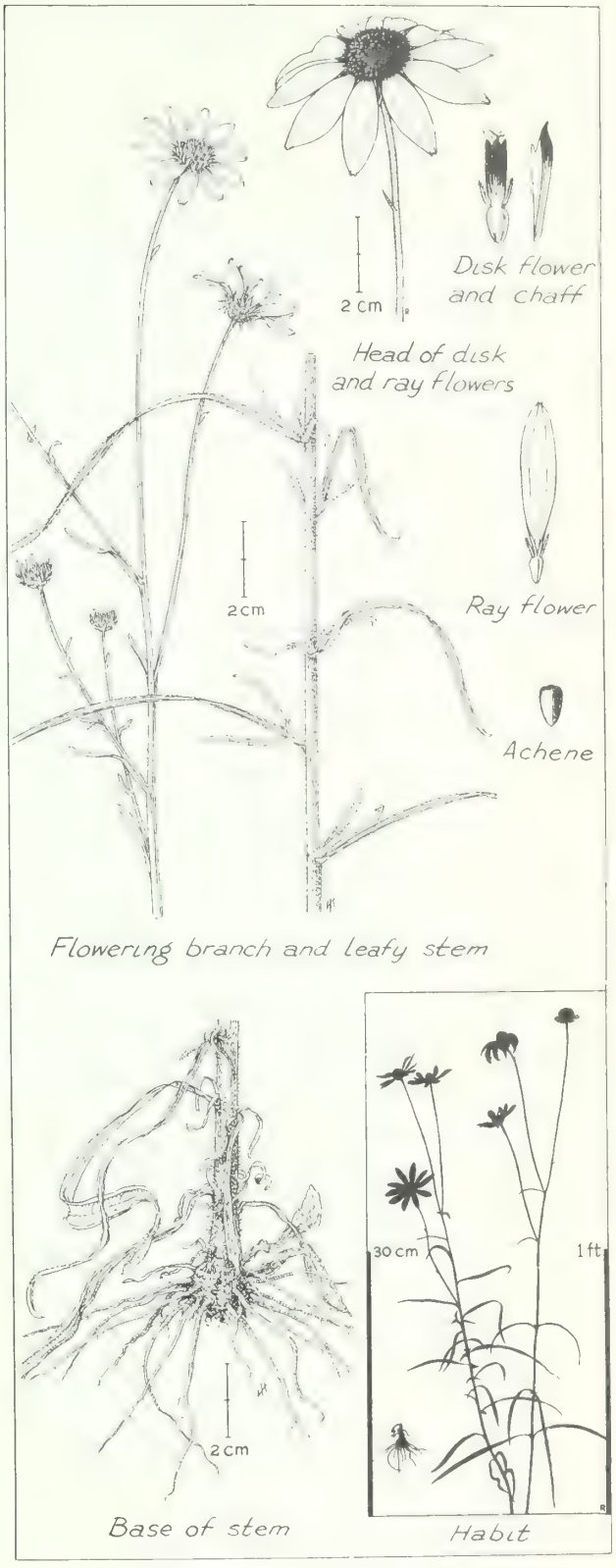
On open sites the leaves average 2½ inches long and less than ⅛ inch wide. They appear even narrower because their margins roll under. Under timber, leaves are flat and up to ¾ inch wide. Heads, 1½ to 2 inches broad, appear in early October. Each has a purplish central disk about ½ inch in diameter and an outer ring of yellow ray flowers. Leaves, though slender, are almost fleshy. They are covered throughout with short, stiff hairs that project from small conical bases.

Although pinebarren ironweed, *Vernonia angustifolia* Michx., resembles swamp sunflower, it is easily distinguished when its flower heads appear in early summer. Its inward-rolled leaves are strongly lance shaped, those of swamp sunflower are almost linear.

Swamp sunflower is the most valuable forage forb on longleaf pine-bluestem range. It is high in protein, often containing more than 10 percent in the full-leaf stage. Unfortunately, it is a minor part of the vegetation, even on lightly grazed range. Cattle eat it throughout the growing season. Grazing causes plants to branch freely. Site preparation, such as disking for direct seeding, causes swamp sunflower to increase. Deer eat the leaves and young stems, and the seeds provide food for quail and doves.

Range: Texas to Florida and New York, inland to Kentucky, Indiana, and Missouri.

Perennial. **Stems** 50-150 cm., branched above, arising from a short, erect crown; **leaves** 8-20 cm. long, 0.3-1.5 cm. wide, simple, sparse to numerous, sessile, alternate (basal sometimes opposite), attenuate, the margins revolute in the very narrow leaves; **heads** many, radiate, 3-7 cm. broad, **involucral bracts** 8-12 mm. long, subulate; **disks** dark purple, 10-15 mm. broad, on a convex, chaffy receptacle; **disk flowers** 6 mm. long, fertile; **chaff** 7 mm. long, red-violet tipped, three-toothed; **rays** 10-13, neuter, bright yellow orange, 1-3 cm. long, 5-6 mm. broad; **achenes** 3-4 mm. long, flattened, dull black, mottled with tan; **pappus** of two caducous scales.



Swamp sunflower

MISCELLANEOUS FORBS

Although composites and legumes are the predominant forbs on longleaf pine-bluestem range, many other forb families are represented. These miscellaneous forbs vary vastly in size, form, appearance, and habitat. They range from the insectivorous sundews, *Drosera* spp., mainly rosettes scarcely larger than a dime, to the robust pokeberry, *Phytolacca americana* L., with specimens occasionally attaining 10 feet. Some—such as butterfly milkweed, *Asclepias tuberosa* L.—are brilliant wild flowers, while many are drab and inconspicuous. Numerous species inhabit only open land; others prefer heavy shade.

Few forbs among this large and interesting array are important as forage for cattle. Most are either insignificant weeds, or they rarely grow in much quantity. Descriptions of several of the commonest follow. Southern bracken, though not a flowering plant, is here included among the forbs.

SOUTHERN BRACKEN

Pteridium aquilinum (L.) Kuhn
var. *pseudocaudatum* (Clute) Heller

Southern bracken, a fern of the family Polypodiaceae, is one of the few conspicuous nonflowering plants in the longleaf pine type. It grows on various sites from open pinelands and abandoned pastures to thickets and frequently burned areas. Although it tolerates dry, sandy soils, it also grows on fertile, moist, heavily wooded sites.

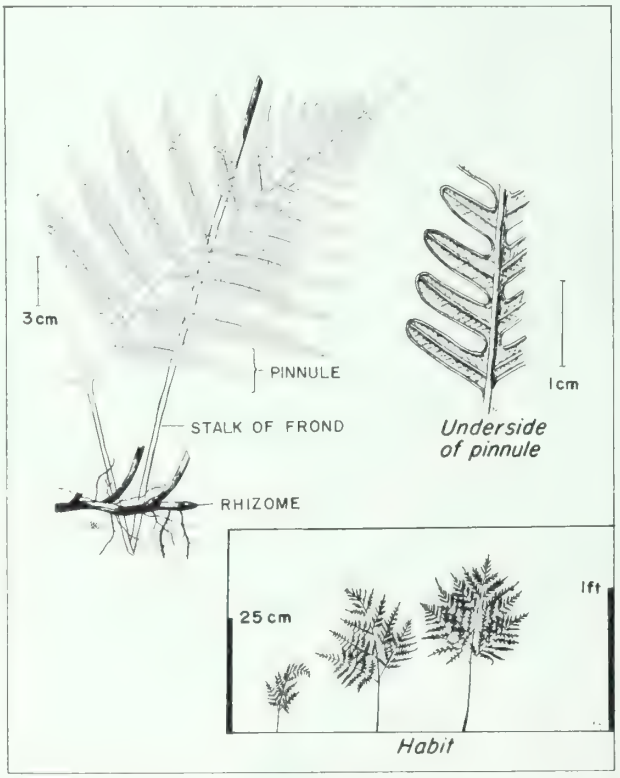
Bracken lacks vertical stems. Coarse, stiffly erect fronds rise to a height of 1 to 5 feet from hairy, horizontal rhizomes. The frond blade, broadly triangular in shape, consists of opposite, finely divided segments. Plant tops are killed by frost, the dead fronds persisting through the winter.

Bracken spreads rapidly by creeping rhizomes, often almost continuously covering extensive areas. Plants produce no seeds; besides spreading by rhizomes, they reproduce by spores, which are barely visible to the naked eye.

Southern bracken is toxic to livestock; fortunately, the fronds are unpalatable. Although cattle and deer sometimes browse the new growth in early spring, they rarely eat enough to be poisoned.

Range: Texas to Florida, north to Massachusetts and inland to Oklahoma, Missouri, Indiana, and Ohio.

Perennial. **Rhizomes** horizontal, hairy, black, elongate, forking, and extensively creeping; **fronds** compound, 30 cm. to 1.5 m. tall, coarse, upright, borne singly and alternately near ends of rhizomes; **stipes** continuous with the rhizome; stipe base dark brown, with scattered hairs; upper stipe straw colored, glabrous; **blades** 20-50 cm. long, tripinnate, broadly triangular in outline with three main divisions; **pinnules** oblong to linear, entire to pinnate, the terminal segments conspicuously elongate, 7-15 times longer than broad, margins revolute to entire or undulate; **sori** marginal, mostly continuous; **sporangia** borne between the modified inrolled margin of the pinnule segment (outer indusium) and the indefinite inner indusium; **spores** minute.



Southern bracken

BUTTON-SNAKEROOT

Eryngium yuccifolium Michx.

Button-snakeroot is a member of the parsley family, Umbelliferae, which includes carrots, celery, and parsnips as well as the deadly poison hemlock, *Conium maculatum* L. It is a deep-rooted perennial, found mostly on moist, upland sites. It spreads by short rootstocks. Stems reach 3 feet in height.

Unlike most members of the parsley family, button-snakeroot has neither divided leaves nor a flat-topped inflorescence. The parallel-veined leaves resemble those of yucca, and the prickly flower heads impart a thistlelike appearance. Basal leaves may reach 18 inches in length, but upper leaves are shorter. Blades, about ½ inch wide at the base, taper gradually to a sharp point. Clusters of two or three stiff bristles are spaced along blade margins at about ½ inch intervals, with one bristle of each cluster usually conspicuously larger than the others. On early leaves, bristles may exceed an inch in length, but on later (upper) leaves, they average ¼ inch.

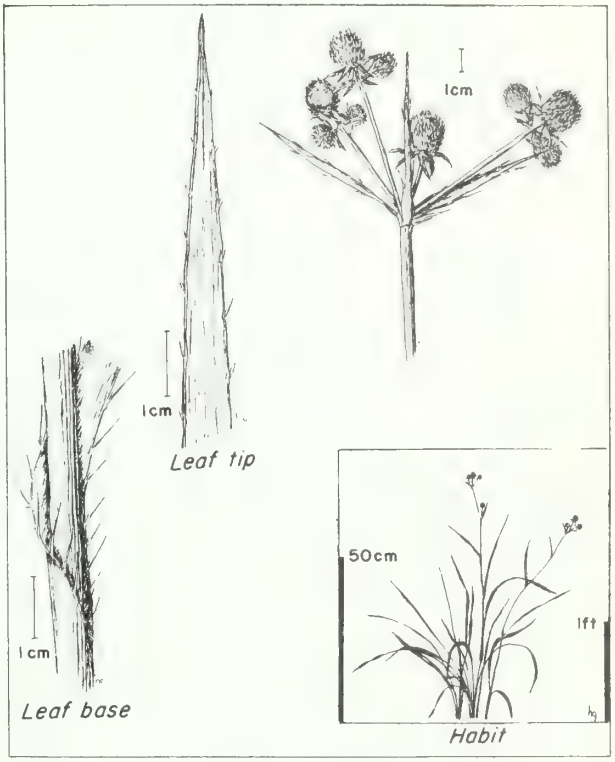
The inflorescence consists of round, many-flowered heads, from ½ to more than 1 inch in diameter. Each head terminates a stout branch of the sparsely branched inflorescence. Individual flowers have five inconspicuous white, or sometimes bluish, petals. Because of sharp scales and harsh, persistent styles, the heads appear and feel bristly. Inflorescences and leaves persist through the winter.

Although several other *Eryngium* species grow in the South, none has the long, bristled, parallel-veined leaves of button-snakeroot.

Cattle graze the leaves before flower stalks emerge, but palatability declines sharply toward maturity. Although this species decreases under heavy use, it rates only fair in forage value.

Range: Texas to Florida, north to Kansas, Minnesota, and New Jersey.

Perennial. Stems 30-100 cm. tall, stiffly erect and solitary from woody root crown, glabrous; leaves linear, parallel-veined, stiff, with one to three linear spines at regularly spaced intervals along each margin; basal blades 15-90 cm. long, 1-3 cm. broad, upper blades reduced; inflorescence a terminal cyme with one to several flower branches in axils of upper leaves; each branch terminated by a long-peduncled ovate head, usually with two smaller heads below, their peduncles opposite and subtended by leaflike bracts; heads many-flowered, each flower above a stiff, sharp bract; terminal head 1-3 cm. long, 1-2 cm. wide, subtended by whorl of linear-lanceolate bracts; flowers five-merous; sepals acute, stiff, persistent, shorter than floral bract; petals deciduous; styles two, persistent, exceeding all other floral parts and bract; fruit an oblong cremocarp, 2-3 mm. long.



Button-snakeroot

WOOLLY CROTON

Croton capitatus Michx.

Woolly croton is an annual weed common on sandy soils throughout the South. Except on severely overgrazed areas, it grows sparingly on the range. Plants are often abundant along roads and on other disturbed sites.

Stems average 2 to 3 feet tall but occasionally exceed 6 feet. The upper ½ to 1/3 is branched, the branches ascending at 45° or less. Young plants are thickly coated throughout with short, brownish or dirty-gray hairs. Toward maturity, the lower stems shed this coating. Hairs are longest on the flowers and divide at the tip into 8 to 10 radiating branches. This starlike arrangement may be seen with low magnification.

Upper leaves are lance shaped, with rounded bases. They are 1 to 3 inches long and ¼ to ¾ inch wide. Petioles are ¼ to ½ the length of the leaves. Lower leaves are frequently longer and more oval than the upper.

The camouflaging effect of the woolly coating renders flowers and fruits inconspicuous. Flower clusters are terminal or in axils of upper leaves. Each cluster has a staminate spike subtended by several pistillate flowers. Staminate flowers have 5 sepals, 5 petals, and 7 to 12 stamens. Pistillate flowers, which are without petals, each have 6 to 8 sepals and a 3-celled, 3-styled ovary.

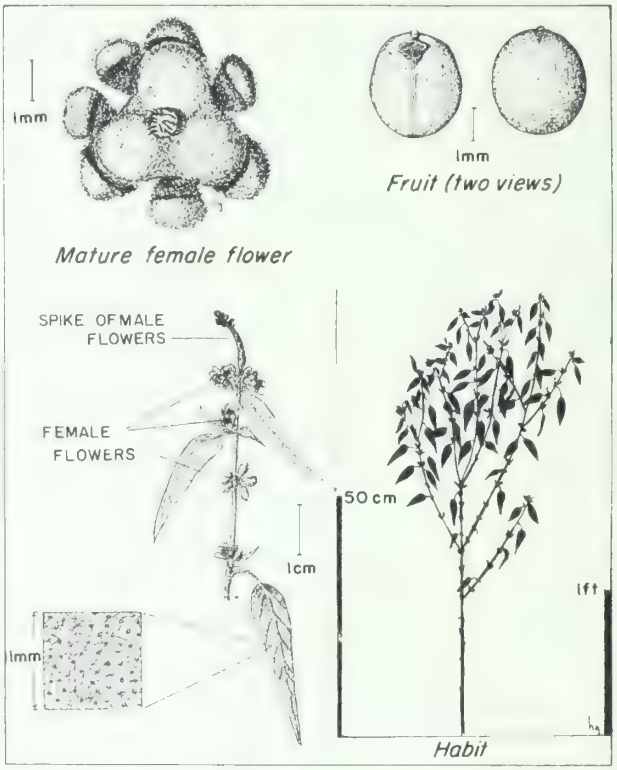
At least one pistillate flower in each cluster matures a three-seeded capsule about ¼ inch in diameter. At maturity, the capsule splits suddenly, ejecting seed with much force. Seeds are about 3/16 inch long, oval, and slightly flattened.

A variety of woolly croton, *C. capitatus* var. *lindheimeri* (Engelm. & Gray) Muell. Arg., also grows on longleaf pine-bluestem range. It is distinguishable by its broader leaves with heart-shaped bases, and petioles from ½ to fully as long as the blades. The hair coating is distinctly reddish brown—much brighter than that of typical woolly croton.

Woolly croton is toxic to livestock; other species are probably poisonous also. The poisonous substance is croton oil, a violent cathartic. Because cattle usually reject woolly croton, even when better foods are scarce, poisoning is rare. The seeds are a choice food for doves and quail.

Range: Texas to Georgia, north to Iowa and New York.

Annual. Plant stems erect, branched; thickly coated with short, brownish, stellate pubescence; leaves 2.5-7.5 cm. long, 5-20 mm. wide, petiole 5-25 mm. long, simple, alternate, entire, lanceolate, tapering to sharp point, base rounded; flowers in compact terminal and axillary clusters, staminate flowers in a spike above pistillate cluster; pedicellate with 5 sepals, 5 petals, 7-12 stamens, pistillate flowers sessile, apetalous, with 6-8 sepals, ovary three-celled, each cell with a style; fruit a globular dehiscent capsule, about 5 mm. long and 7 mm. wide; seeds 3 (2-4) per capsule, oval in outline, somewhat flattened.



Woolly croton

POOR-JOE

Diodia teres Walt.

Poor-joe, or rough buttonweed, is a slender annual. Although inconspicuous, it is usually present on longleaf pine-bluestem sites. Plants often grow abundantly on road shoulders, old fields, firelanes, and trails. The name refers to its commonness and abundance on badly depleted cropland.

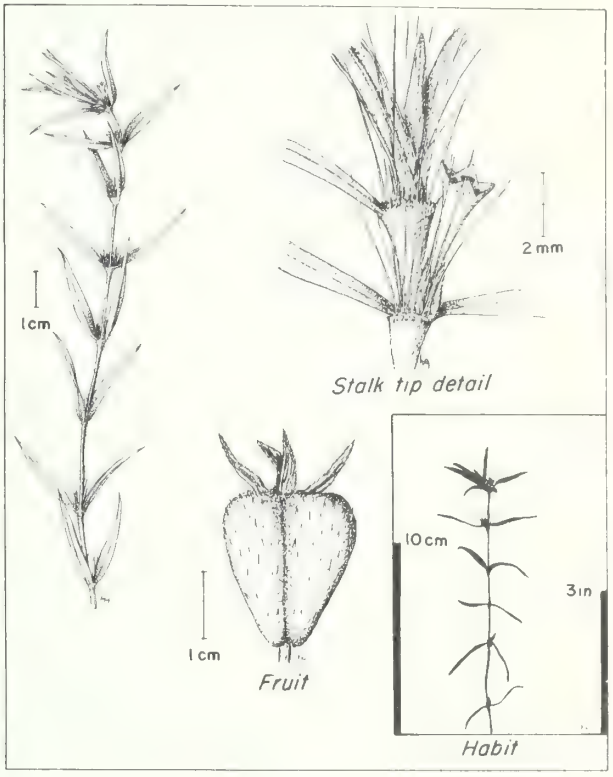
In competition with better range plants, poor-joe usually grows as scattered single stems about 4 inches long. In old fields and other heavily disturbed sites, plants branch profusely. They often form dense, low-growing colonies up to 4 feet in diameter. The opposite leaves are about 1 inch long and 3/16 inch wide. Small, tubular, white or pinkish flowers are borne singly in leaf axils. Brown bristles about ¼ inch long form a cluster in each leaf axil. The clusters persist after fruit and leaves fall.

Virginia buttonweed, *Diodia virginiana* L., is a spreading perennial common on poorly drained sites in central Louisiana. While cattle eat it readily, a prostrate habit enables plants to stand heavy grazing. A fleshy taproot permits survival during drought. Although its flowers and fruits resemble those of poor-joe, its leaves are elliptical and two to four times broader, though not longer.

Where poor-joe is abundant, as on freshly burned range, cattle eat young plants along with grass herbage. Toward maturity, palatability declines rapidly. Deer eat the foliage, and quail eat the seeds.

Range: Texas to Florida, north to Kansas, Michigan, and Connecticut.

Annual. Stems to 30 cm., pubescent, simple or branched, erect to spreading; leaves simple, opposite, entire, linear or linear-lanceolate, 1-4 cm. long, 2-3 mm. wide, scabrous; flowers solitary in upper leaf axils, four-merous; corolla white to pink, gamopetalous, 4-5 mm. long, calyx 2 mm. long, sepals acute; fruit a two- or rarely three-locular capsule 4-5 mm. long, individual carpels hard and indehiscent.



Poor-joe

SHRUBS AND WOODY VINES

On areas that are grazed yearlong and burned periodically, shrubs and woody vines usually comprise less than 5 percent of the understory, occurring mainly as small, scattered plants. Where not held in check by fire and grazing, however, they may form dense thickets over large areas.

With a few notable exceptions, the common shrubs and vines rate poor to fair as cattle forage. Although their leaves and twigs may be nutritious, most are either unpalatable or too scarce to furnish significant amounts.

Practically all browsing by cattle is between mid-December and early April. During this period, foliage of evergreen shrubs and vines, as well as twigs of deciduous woody plants, help supply protein and phosphorus needed to supplement the dry grasses. On upland ranges, however, the value of browse as winter food is often exaggerated, for it usually comprises only 2 or 3 percent of the yearlong diet.

Several shrubs and vines are toxic. Carolina jessamine, for example, contains a poison that has reportedly killed both livestock and humans. Contact with poison-ivy and poison-oak yearly causes much severe dermatitis among people who venture into the forest.

Foliage, stems, and fruits of numerous woody plants are important foods for birds and game animals. Evergreen species, such as yaupon and swamp cyrilla, are especially valuable for deer browse.

AMERICAN BEAUTYBERRY

Callicarpa americana L.

American beautyberry, perhaps better known as French-mulberry, is a common understory shrub throughout the South. It tolerates a wide variety of sites, but grows best on moist soils under high, fairly open, pine canopies. Though not as fire tolerant as waxmyrtle, American beautyberry is more persistent than most shrubs on ranges that are burned periodically.

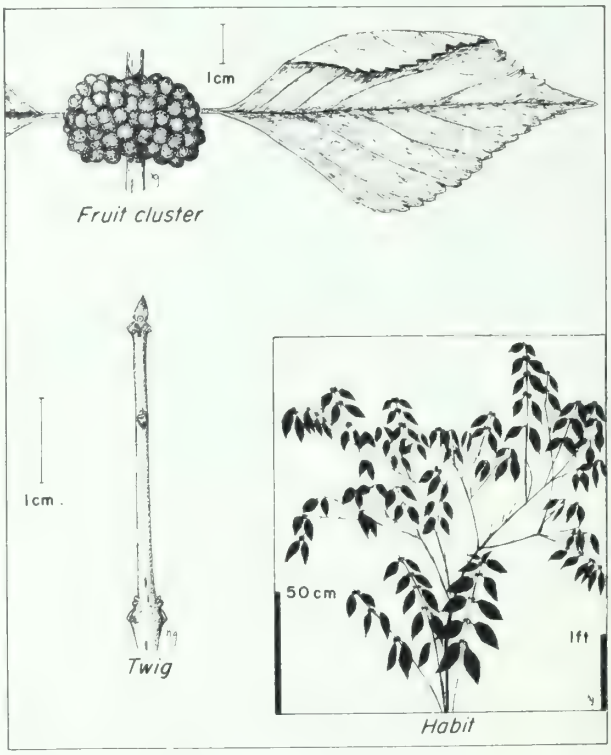
Plants range from small bushes 2 feet tall to many-branched shrubs reaching 8 feet. The aromatic leaves are simple, opposite, and egg shaped to elliptical, with coarsely toothed margins; length is 3 to 9 inches. Twigs, leaf petioles, undersides of leaves, and veins on the upper surfaces of leaves are thinly coated with woolly, yellow-brown hairs.

Axillary clusters of small flowers are produced through the summer and early fall on current growth. Even while new flowers are being formed, along with new leaves, at the branch tip, mature fruits are often present among the lower leaves. Flowers are about ⅛ inch long and pale blue to pale pink. Mature fruits, ⅛ to ¼ inch in diameter, are brilliantly violet to reddish purple. They are conspicuous in fall and early winter in dense, spherical clusters that encircle the stem at regular intervals. A fruit contains four seeds, each about 1/16 inch long.

Deer readily eat the leaves, twigs, and fruits. Cattle take the leaves after grass matures and browse the twigs during winter. The berries are preferred food for many birds and small mammals.

Range: Eastern Texas, eastern Oklahoma, and southern Missouri to Florida and Maryland.

Stems 1-2 m. tall, brittle, twigs stellate and tomentose; leaves simple, deciduous, opposite or sometimes ternate, petiolate, blades 8-23 cm. long, 4-13 cm. wide, coarsely serrate to dentate, ovate to elliptic, acute to acuminate, aromatic, lower surface and petiole stellate and tomentose; flowers perfect, four-merous, 2-4 mm. long, axillary in dichotomous cymes; petals rose to pink or pale blue (rarely white); fruit a four-seeded drupe, 2-4 mm. in diameter, violet or reddish purple, rarely white.



American beautyberry

BUCKWHEAT-TREE

Cliftonia monophylla (Lam.) Britton

Buckwheat-tree, also called titi and black titi, normally is an evergreen shrub, though sometimes it reaches tree size. It grows mainly in swamps and bays and along streams, often in association with swamp cyrilla. Its racemes and fruits resemble those of buckwheat.

Leaves are alternate, firm, and more or less elliptical. The smooth margins are rolled under slightly. Blades are 1½ to 2½ inches long and ½ to ¾ inch wide. Except for the midrib, veins are inconspicuous. Leaf surfaces are often coated with a white bloom. Many leaves persist for two growing seasons.

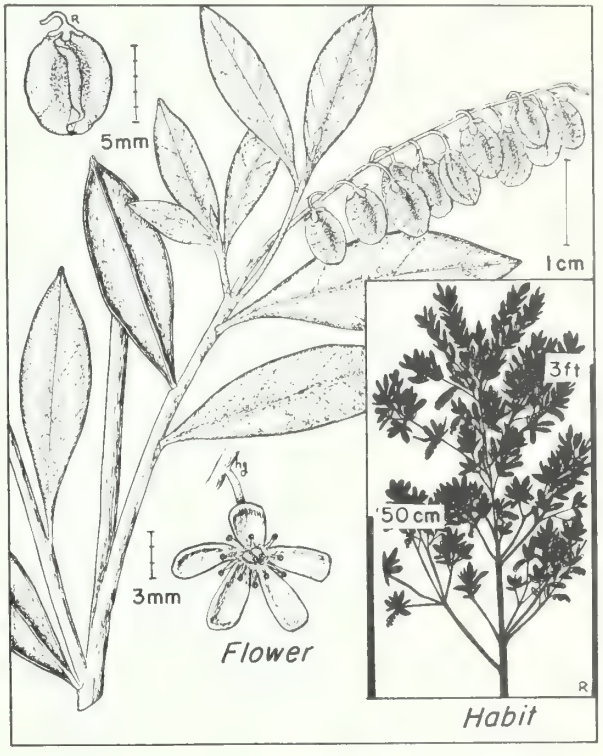
Flowering, from late February to mid-April, precedes new vegetative growth. Flowers are in a single raceme about 2½ inches long at the top of each fruiting branch. Later, new vegetative shoots arise from a whorl of lateral buds at the base of the raceme. In swamp cyrilla, this arrangement is reversed, with a whorl of racemes being produced at the base of a terminal vegetative shoot. The two species also differ in date of maturity. Fruits of buckwheat-tree are fully formed by the time cyrilla reaches the full-bloom stage.

Flowers are fragrant and about ¼ inch in diameter, each with five to eight white to pinkish petals and an equal number of minute sepals. The fruit is an oval capsule having two to four longitudinal wings and containing two to four seeds.

Buckwheat-tree provides good browse for deer, and cattle feed on the leaves and twigs when other green forage is scarce. It is also a good honey plant; the nectar is often included with that of cyrilla in "titi" honey.

Range: Coastal pinelands, southeastern Louisiana to Florida and South Carolina.

Stems profusely branching, to 15 m. tall; **leaves** simple, alternate, elliptic-oblanceolate, coriaceous, entire, 3.5-6 cm. long, 12-18 mm. wide, revolute, often glaucous, persistent; **flowers** in terminal racemes, sepals and petals five to eight, petals white to pinkish, 4-5 mm. long, stamens 10; **racemes** 2.5-9 cm. long; **fruit** a two- to four-celled indehiscent capsule, ovoid to oval, 6-7 mm. long, two- to four-winged.



Buckwheat-tree

SWAMP CYRILLA

Cyrilla racemiflora L.

Few plants are known by as many common names as this evergreen shrub of the Coastal Plain. Ironwood, he-huckleberry, red titi, white titi, and leatherwood are among those applied. Swamp cyrilla is a principal component of titi swamps and thickets in Florida, Alabama, and Mississippi. It also forms dense borders along streams and ponds, often mixed with the closely related buckwheat-tree.

Swamp cyrilla may reach 30 feet in height and 1 foot in trunk diameter, but commonly is 15 feet or less in height and no more than 6 inches in diameter. Stems branch profusely, forming almost impenetrable thickets.

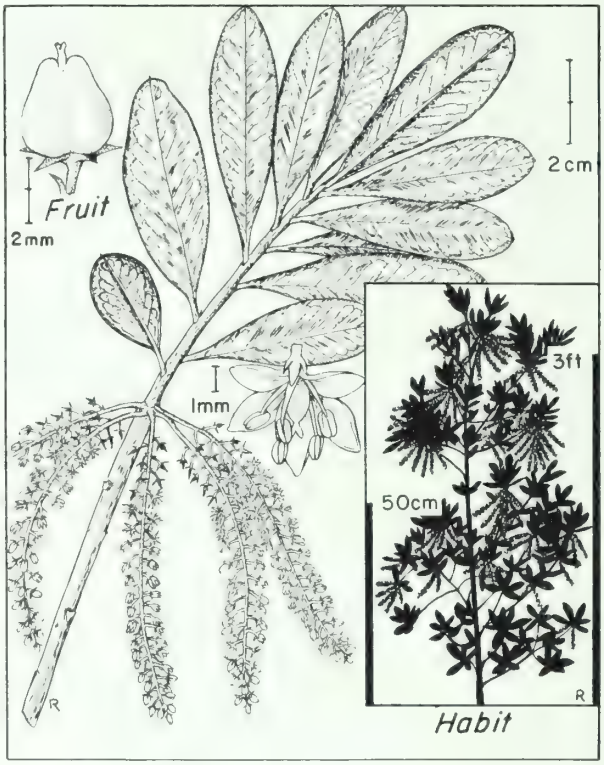
Plants are smooth and hairless throughout. Leaves are alternate, 2 to 4 inches long, and ¼ to 1 inch wide. Their texture is leathery, and shape varies from ovate to elliptical. The blades have a profuse network of prominent veins. Leaves remaining on plants in winter turn red or orange.

In the spring, white-petaled flowers are borne in cylindrical racemes 3 to 6 inches long. Whorls of 6 to 10 racemes encircle branches where current growth joins that of the previous season. Each flower is less than ¼ inch wide and has 5 sepals, 5 petals, and 5 stamens.

Cyrilla is a preferred browse plant for deer. In thickets, it also provides escape cover for wildlife. Honey from cyrilla flowers is esteemed by many residents of the southeastern Coastal Plain. Cattle may eat the leaves in winter if better feed is lacking.

Range: Coastal Plain, from east Texas and southern Missouri to Florida and southern Virginia.

Stems to 10 m. in height and 30 cm. in diameter, branches spreading, irregular; **leaves** simple, entire, persistent, alternate, glabrous, lustrous and dark green above, lighter and duller below, mature leaves conspicuously reticulate-veined, 5-10 cm. long, 7-25 mm. wide, oblanceolate or obovate to nearly elliptic; **flowers** in cylindrical racemes 8-15 cm. long; **sepals** five, 1 mm. long, ovate to ovate-lanceolate, greenish; **petals** five, 3-5 mm. long, oblong-lanceolate, white; **fruit** an ovoid-conic two-celled capsule 2-3 mm. long, gray to yellow brown with remnant of style at apex; **seed** two in each cell, minute, brown.



Swamp cyrilla

YAUPON

Ilex vomitoria Ait.

This stiffly branching evergreen of the holly family, Aquifoliaceae, grows throughout the southeastern United States. It inhabits a variety of sites, but is usually most abundant on moist, sandy soils. Although plants may reach a height of 30 feet and a trunk diameter of 14 inches on unburned areas, few attain this size. Burning at moderate intensity usually kills the tops and promotes sprouting. Such fires are beneficial, as they keep foliage in reach of deer and cattle. Intense burning eliminates yaupon.

Young stems and branches have a smooth, whitish-gray bark, and it is difficult to see where current-season growth began. Leaves are alternate, rather thick, hairless, and shiny. Although length varies considerably, even on a single branch, it averages ¾ to 1 inch. Width is about ½ length. Most leaves are broadly elliptical. Shallow, blunt teeth lend a wavy appearance to blade margins. Leaves persist for two growing seasons, usually falling as new growth begins in the third season.

Yaupon flowers, like those of other hollies, are unisexual, with male and female flowers usually borne on separate plants. Flowers of both sexes average ¼ inch in diameter. The four or five small white petals are subtended by an equal number of green sepals. Male flowers have four or five yellow stamens and a rudimentary pistil; female flowers have four or five rudimentary stamen filaments and a fertile pistil. Flowering is in early spring on branches of the previous growing season.

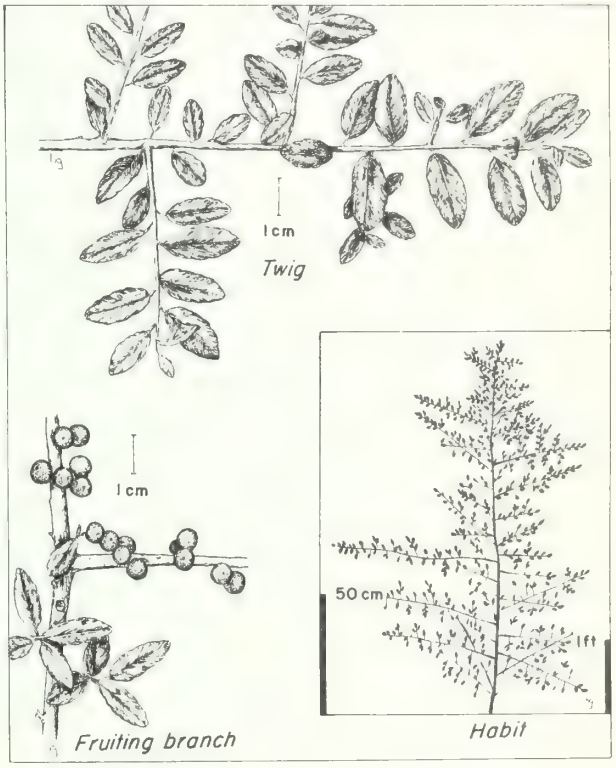
The glossy red berry is technically a drupe, usually containing four nutlets. Drupes are about ¼ inch in diameter; the ribbed nutlets average 1/6 inch long. The fruits may remain on the stems through the winter, but migrating birds, such as the cedar waxwing, frequently strip the plants clean by mid-March.

Yaupon is an excellent browse plant. Deer eat the fruits as well as leaves and twigs. When green grass is scarce, cattle often browse yaupon intensely, causing plants to assume a dense, closely hedged form.

A holly closely resembling yaupon is myrtle dahoon, *Ilex myrtifolia* Walt., which grows on wet sites in the lower Coastal Plain from Louisiana to North Carolina. Leaves of myrtle dahoon, though evergreen and about the same size and shape as those of yaupon, have smooth margins.

Range: South-central Texas and southeastern Oklahoma to Florida and southeastern Virginia.

Stems to 7.5 m. tall and 30 cm. in diameter, much branched, with whitish-gray, smooth bark; leaves simple, alternate, persistent, lustrous, glabrous, coriaceous, elliptic to elliptic-oblong, 1-5 cm. long, 0.5-2.5 cm. wide; flowers polygamodioecious, four- or five-merous, sepals 1 mm. long, petals 2-3 mm. long; staminate flowers in three- to nine-flowered, short peduncled cymes; pistillate flower in one- to three-flowered cymes, nearly sessile; fruit a shiny, red, globose drupe, 5-6 mm. in diameter, with four ribbed nutlets.



Yaupon

GALLBERRY

Ilex glabra (L.) Gray

This holly is often the most abundant understory shrub on wet sandy flatwoods and along streams in the lower Coastal Plain from Florida to eastern Louisiana. On unburned sites, height may reach 10 feet, but frequent burning keeps it below 5 feet. When tops are killed by fire, numerous sprouts arise from underground, causing plants to spread. Because fire often destroys competing woody species, gallberry may form almost continuous understories in frequently burned timber stands.

The leaves are alternate and elliptic to lance shaped, usually with three low, blunt teeth on each side toward the tip. They generally resemble those of yaupon, which is often associated with gallberry, but margins of yaupon leaves are toothed throughout.

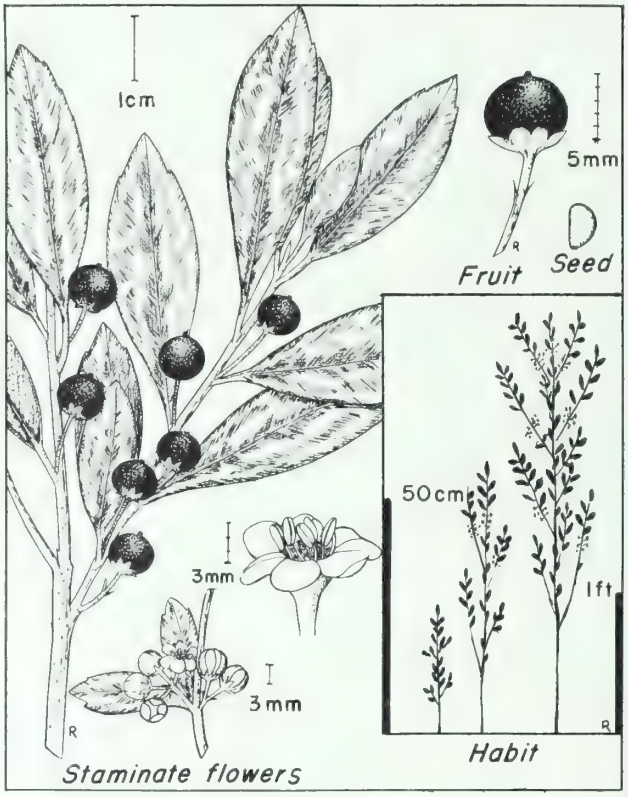
Male and female flowers are on separate plants. Since the plants often spread vigorously by sprouting, all stems in a large colony may be from a single plant, and hence will have flowers of the same sex. Flowers of both sexes are similar, with five to eight small white petals. Male flowers have four to six fertile stamens and a sterile ovary. In female flowers, the ovaries are functional, but stamens are rudimentary stumps.

Female plants are usually prolific seed producers. The berrylike fruits are about ¼ inch in diameter. They are green during most of the summer, but turn black at maturity. Only one other holly, large gallberry, *Ilex coriacea* (Pursh) Chapm., bears black fruit. In large gallberry, leaves average nearly 1 inch wide—almost four times broader than the average for gallberry.

Gallberry is objectionable because it seriously impairs herbage production and creates a fire hazard. Cattle seldom eat the foliage. Swamp rabbits, and possibly other small mammals, eat the leaves. The fruits, like those of most hollies, are eaten by a variety of birds, including wild turkey and quail.

Range: Coastal Plain, from eastern Louisiana to Florida, north to Massachusetts.

Stems erect, to 3 m. tall; twigs velvety pubescent; leaves simple, persistent, alternate, oblanceolate, 1-5 cm. long, short-petioled, usually serrate above the middle, lustrous deep green above, paler beneath; flowers white, axillary, pedicellate, on polygamodioecious plants, the staminate in corymbs of several flowers, the pistillate often solitary; fruit a drupe 4-6 mm. in diameter, globose, shining black at maturity, on pedicels longer than the fruit; nutlets smooth on the back.



Gallberry

CAROLINA JESSAMINE

Gelsemium sempervirens (L.) Ait. f.

Carolina jessamine, or yellow jessamine, is a common native evergreen vine. It is not closely related to the cultivated jessamines or jasmines of the genera *Jasminium* and *Cestrum*.

Carolina jessamine may inhabit all except dry, open, sandy areas. It grows best in wooded stream bottoms. In forests, plants often climb 20 feet or higher on trees. On moist, sparsely timbered sites, they may form loose mats on the ground and on low shrubs. Climbing is by twining of the rapidly growing terminal shoot.

The slender stems are reddish brown, often with a whitish bloom. Leaves are opposite with lance-shaped blades 1 to 3 inches long and up to ½ inch wide. Upper surfaces are a dull, light green; lower surfaces are pale. Blades are thinner than those of most evergreen plants. Stems and leaves are hairless.

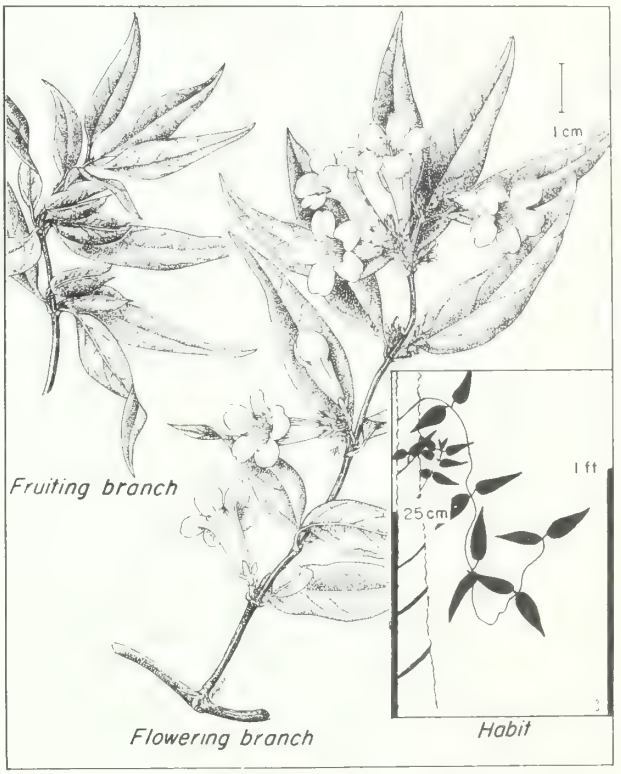
Scaly-stalked clusters, with two to six flowers each, arise from leaf axils on shoots produced the previous season. Flowering begins in late winter, before the start of vegetative growth, and continues until midspring. Five sepals, each about 3/16 inch long, appear separate but are actually joined basally. Petals fuse into a funnel-shaped tube about 1 inch long with five shallow lobes. Flowers are fragrant.

The fruit is a capsule ½ to ¾ inch long with a short beak at the tip. At maturity the capsule splits into two valves and releases numerous flat, winged seeds, each about ¼ inch long.

All parts of the plant contain alkaloids related to strychnine. Although these are considered poisonous to all kinds of livestock and to humans, deer browsing the foliage are apparently unaffected. Poisoning of cattle is rare, possibly because the vines frequently climb beyond reach of grazing animals.

Range: Southeastern Texas and Arkansas to Florida and southeastern Virginia.

Stems glabrous, twining, commonly climbing to 6 m. or forming tangled mat if climbing support not available; leaves simple, opposite, entire, glabrous, persistent, lanceolate to ovate, short-petioled, 1.5-7.0 cm. long, 6-15 mm. wide; flowers in one- to six-flowered axillary cymes, fragrant; corolla yellow, gamopetalous, five-lobed, 2-4 cm. long; calyx deeply five-lobed, lobes oblong-elliptic, obtuse, 5 mm. long; fruit a dehiscent, two-celled, many-seeded capsule, oblong or elliptic, 1.5-2.0 cm. long, short-beaked; seeds flat, winged, 6-9 mm long.



Carolina jessamine

TREE SPARKLEBERRY

Vaccinium arboreum Marsh.

Tree sparkleberry, also known as tree-huckleberry or farkleberry, is an evergreen shrub or small tree of the heath family, Ericaceae. In the absence of fire, especially on fertile bottom-land soils, it reaches 30 feet or more—taller than any other native *Vaccinium*. On frequently burned sites, plants grow mainly in small colonies and stems are about 3 feet tall. On wet, sandy soils, tree sparkleberry is commonly associated with southern wax-myrtle.

Leaf shape is broadly ovate to elliptical. Blades are ¾ to 2 inches long, and width is about 2/3 the length. Leaf margins are smooth; tips are usually rounded, but some are pointed. Upper leaf surfaces are dark green, hairless, and shiny; the paler lower surfaces may be slightly hairy. Flowers, born in racemes on branches of the previous season, appear shortly after new leaves emerge. They are subtended by bracts that closely resemble the leaves in shape and texture but are much smaller.

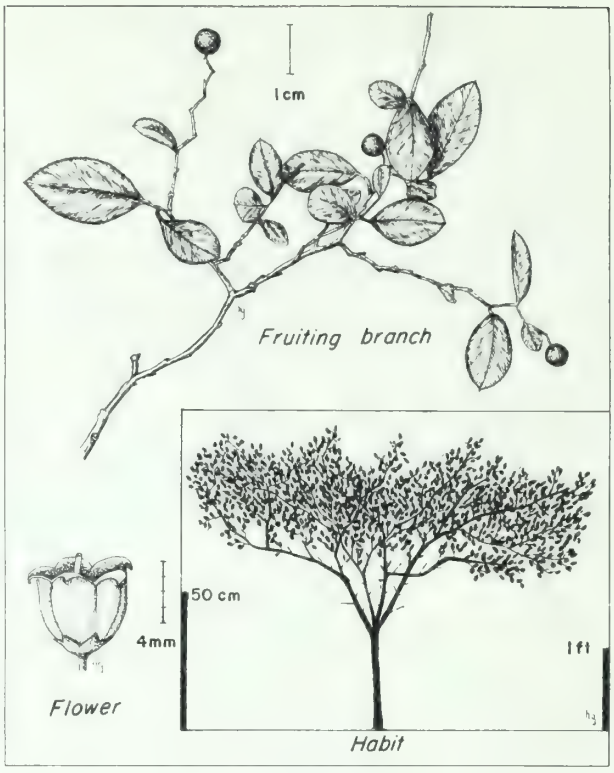
Sepals are united and small; the five white or pinkish petals, united except at the tips, form bell-shaped corollas about ¼ inch long. Each flower produces a fleshy, many-seeded berry. Upon ripening in late summer and fall, berries turn black. They persist on plants well into winter.

Elliott blueberry, *Vaccinium elliottii* Chapm., often grows in association with tree sparkleberry. It flowers in late winter before leaves appear—much earlier than tree sparkleberry—and its leaves are finely toothed along the margins. Other *Vaccinium*s and several closely related huckleberries (*Gaylussacia* spp.), occur on longleaf pine-bluestem range, but none are generally abundant.

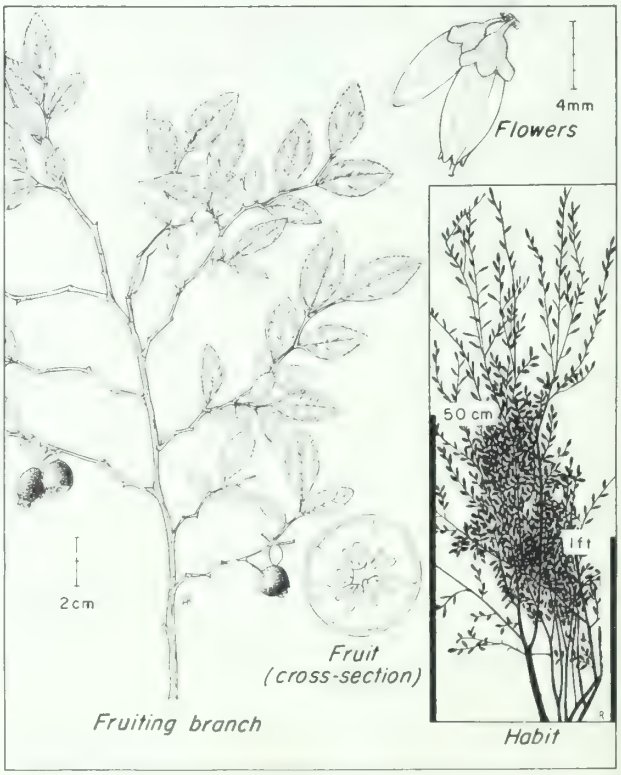
Cattle browse both tree sparkleberry and Elliott blueberry lightly during winter but seldom during the growing season. The fruits are eaten by a variety of birds.

Range: Texas and Oklahoma to Florida, Illinois, and Virginia.

Stems 2-9 m., much-branched, branches stiff and divergent; **leaves** simple, alternate, persistent, obovate to oval or elliptic, coriaceous, entire or obscurely denticulate, 2-5 cm. long, 0.5-3.5 cm. wide; **flowers** perfect, long-peduncled, 5-6 mm. long, in loose, leafy-bracted racemes; **perianth** five-merous, gamosepalous, gamopetalous, petals white or pinkish; **stamens** 10, included in corolla; **fruit** a globose, shiny berry about 8 mm. in diameter, black at maturity with many hard seeds.



Tree sparkleberry



Elliott blueberry

ST.-ANDREWS-CROSS

Hypericum hypericoides (L.) Crantz

This member of the St.-Johns-wort family, Guttiferae, is a diffusely branched deciduous shrub that grows mainly on sandy sites. Plants seldon exceed 3 feet high. Frequent burning reduces size materially, causing this shrub to resemble a small forb.

Stems of St.-Andrews-cross are dark brown with stringy, fibrous bark. Leaves are opposite but may appear whorled. Blades are smooth margined, hairless, and linear to oblong. They are ¾ to 1¼ inches long, and about ⅛ to ¼ inch wide. Their surfaces are dotted with small, dark depressions.

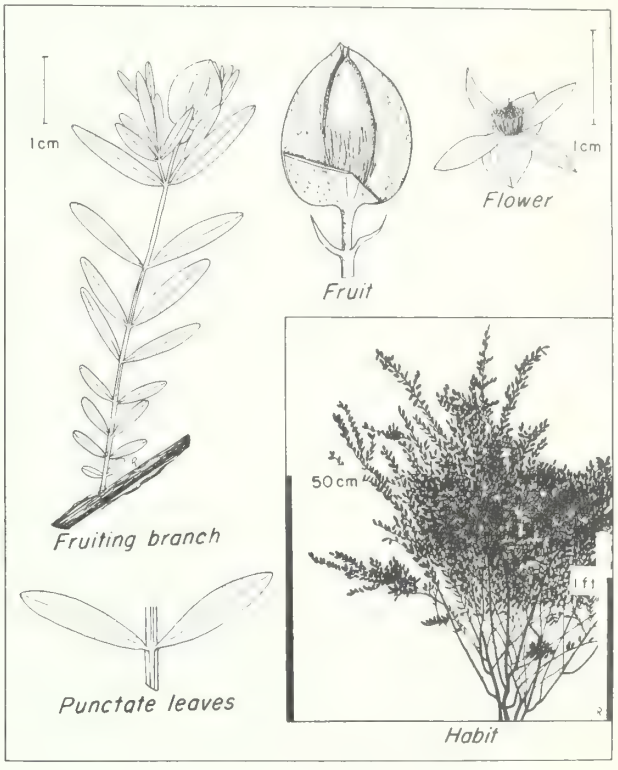
Flowering begins in early summer and continues into fall. Flowers are less than 1 inch wide, with four sepals, four petals, and numerous stamens. The pale yellow petals fall quickly, but sepals remain until seeds mature. The two outer, opposite sepals are much larger than the inner pair and clasp the developing capsule until dispersal of the numerous tiny hard seeds. After petals fall, flowers appear as flattened, egg-shaped, podlike structures.

Atlantic St.-Peters-wort, *Hypericum stans* (Michx.) Adams & Robson, resembles St.-Andrews-cross. The most obvious difference is in the anatomy of the flowers; those of Atlantic St.-Peters-wort have three or four styles, those of St.-Andrews-cross, only two.

St.-Andrews-cross is of little forage value. Cattle probably graze small plants inadvertently, and deer browse it when better forage is scarce.

Range: Texas and Nebraska to Florida and Massachusetts.

Stems erect, diffusely branched, to 1 m. tall, branches dark brown, bark fibrous, stringy; **leaves** simple, deciduous, opposite with axillary fascicles of reduced leaves, pale green, punctate, glabrous, linear to oblanceolate, sessile, 2-3 cm. long, 2-5 mm. wide; **flowers** terminal and axillary, solitary; **sepals** four, punctate, dimorphic, the outer pair subcordate, 7-9 mm. long, 3-10 mm. broad, the inner ones minute; **petals** four, pale yellow, 8-10 mm. long, 1.5-4 mm. broad; early deciduous; **capsule** of two carpels, 7-8 mm. long, beaked by the two persistent styles, enclosed in the persistent sepals; **seeds** small, numerous.



St.-Andrews-cross

POISON-IVY

Rhus radicans L.

Although poison-ivy may be encountered almost anywhere on longleaf pine-bluestem range, it grows mainly on moist, wooded sites, especially stream bottoms. Plants are usually vines, climbing by aerial roots that adhere to the bark of trees and shrubs. Lacking supporting vegetation, plants may either sprawl on the ground or assume a shrubby habit.

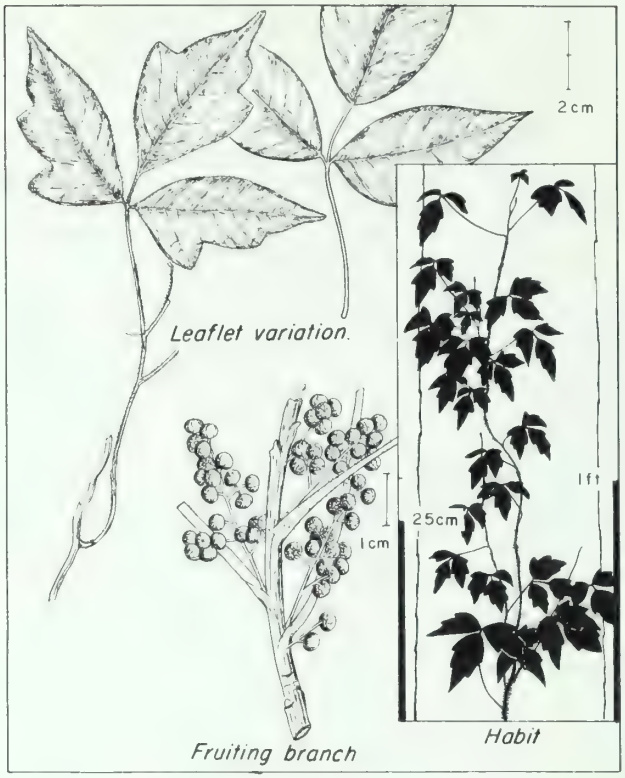
Leaves have three leaflets, each 1 to 4 inches long. In typical specimens, leaflet margins are lobed or coarsely toothed. This character is not constant, however, as margins of some leaflets are smooth. Inconspicuous, small, green flowers are in loose axillary panicles. Flowers are unisexual, the male and females often on separate plants. The fruits are yellowish green, berrylike, and about ¼ inch in diameter. They become blue gray in fall.

Poison-ivy is best known for the severe human dermatitis it often causes. Several other members of the cashew family, Anacardiaceae, are similarly poisonous. Two of these, poison-oak, *Rhus toxicodendron* L., and poison-sumac, *R. vernix* L., are common in the longleaf pine type. Poison-oak is frequently confused with poison-ivy, as the two are similar in several respects. Poison-oak inhabits relatively dry upland pine sites. It does not climb, but creeps by underground stems, forming colonies of shrubby sprouts 1 to 2 feet tall. Poison-sumac is readily distinguishable from both poison-oak and poison-ivy. The poison-sumac leaf has 7 to 13 leaflets, 1 terminal and the others in lateral pairs. Although shining sumac is similar in leaflet arrangement, it is readily distinguished from poison-sumac by its winged leaf rachis.

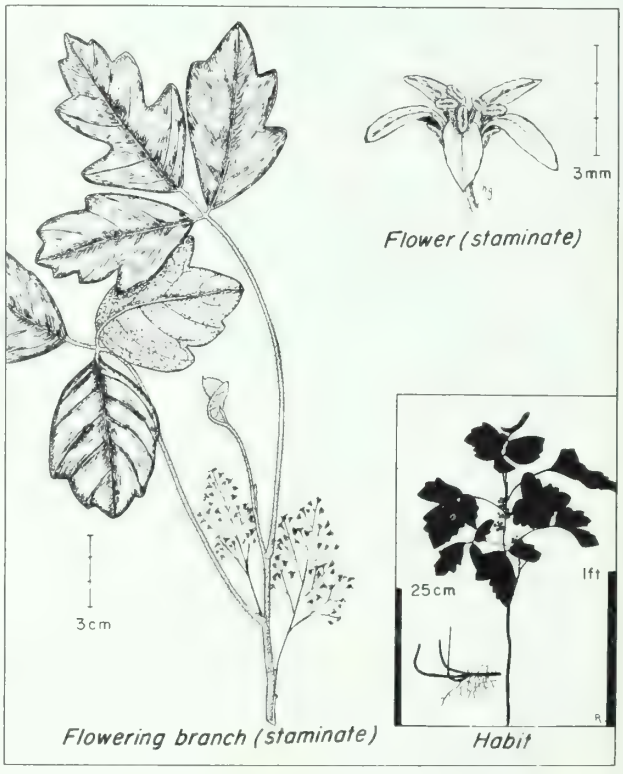
Poison-ivy and poison-oak have little forage value for cattle. During winter, deer may occasionally browse both species, and quail eat poison-oak fruits when better food is scarce.

Range: Throughout the United States, except the Far West.

Stems low climbing to shrubby; **leaves** deciduous, alternate, trifoliolate, long-petiolate; **leaflets** thin, ovate-lanceolate, acuminate, margins dentate or lobed to entire, glabrous above, glabrous to variously pubescent below; **flowers** polygamodioecious, 1.5 mm. wide, in axillary panicles; **fruit** a drupe, 3-6 mm. in diameter, dun-colored to whitish, waxy.



Poison-ivy



Poison-oak

SHINING SUMAC

Rhus copallina L.

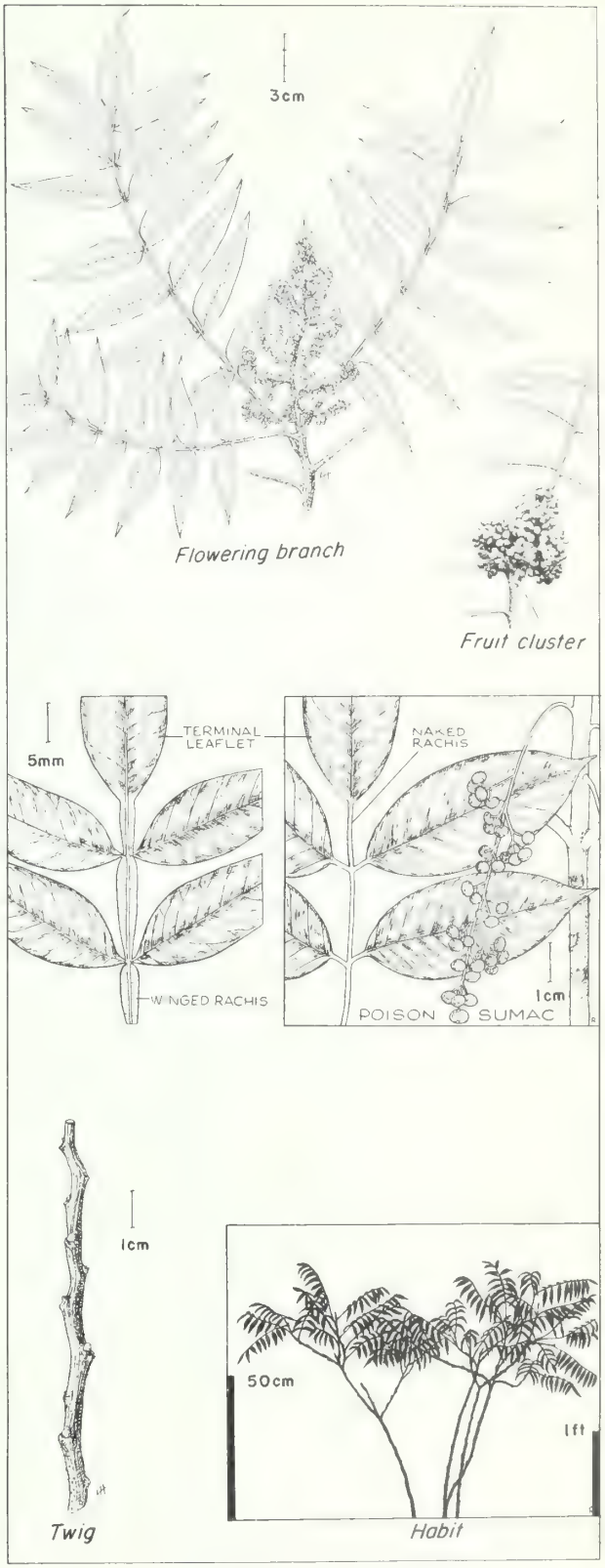
Shining sumac is a nonpoisonous member of the cashew family, Anacardiaceae, which also includes poison-oak and poison-ivy. On frequently burned range, plants usually occur in colonies and stems average less than 3 feet tall. In the absence of fire they assume tree form, reaching 30 feet. This species grows most commonly on sandy sites, especially along the edge of forest clearings.

The leaves are 6 to 10 inches long and odd-pinnately compound. The 9 to 21 leaflets consist of one terminal leaflet and 4 to 10 lateral pairs. Leaflets are broadly lance shaped to elliptical and about 2 inches long; the upper surfaces are green and shining, the lower pale and dull. This species is distinguishable from other sumacs by a winged leaf rachis that is about ⅛ inch wide and resembles the leaflet in color and texture. The bark of twigs is conspicuously spotted with small, dark, warty protuberances. The erect terminal panicles of small greenish-white flowers appear in May. The fruits are red, fleshy, one-seeded, hairy, and about ⅛ inch in diameter. Many persist on the panicles through the winter.

Quail and other birds eat the fruits. Cattle and deer may eat twigs during winter.

Range: Texas, Oklahoma, and Missouri to Georgia, Michigan, and New Hampshire.

Stems to 10 m. tall, spreading, usually colonizing; **leaves** deciduous, 15-35 cm. long, odd-pinnately compound, the rachis winged; **leaflets** 9-21, 3-8 cm. long, 1-2 cm. broad, shining green above, dull beneath, acuminate at the tip, mostly entire; **inflorescence** a dense, upright panicle of greenish flowers; **fruit** a drupe, obliquely spheroid, bright red, 4 mm. in diameter, finely pubescent, glandular, often persistent; **seeds** smooth, light brown, 2-3 mm. long, 2.5-3.5 mm. wide.



Shining sumac

ALABAMA SUPPLEJACK

Berchemia scandens (Hill) K. Koch

Alabama supplejack, known also as rattanvine, is a high-climbing woody vine common on fertile, moist sites. The twining stems may girdle and eventually kill large trees.

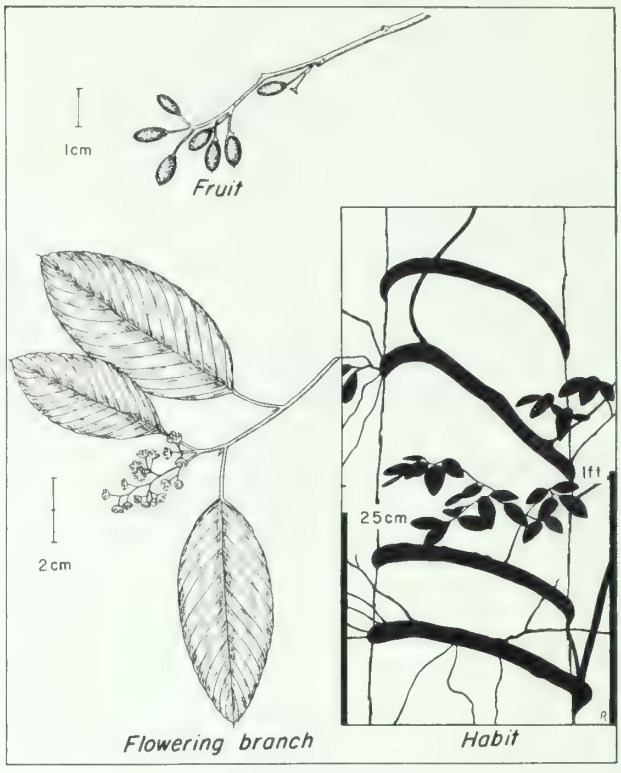
The leaves are alternate, oval to elliptical, about 1½ inches long and ¾ inch wide. The upper leaf surfaces are dark green, hairless, and shiny; the lower surfaces, also hairless, are light green and dull. Margins are usually wavy but may be toothed or smooth. Conspicuous, straight, parallel veins extend at about a 30° angle from the midrib.

Small greenish-yellow flowers are borne in loose clusters at the tips of branches. Sepals, petals, and stamens number five each; all average ⅛ inch long. Fruit is a bluish-black drupe, oblong or ellipsoid in shape, and about ¼ inch long.

Cattle browse new growth in spring, but most of the foliage is beyond their reach. Several species of birds, including turkey and bobwhite quail, feed on the fruit.

Range: Texas and Missouri to Florida and Virginia.

Stems high-climbing, twining, much-branched, glabrous, tough and pliant; **leaves** simple, alternate, deciduous, dark green and shiny above, lighter and dull below, conspicuously parallel-veined, 3-6 cm. long, petioles about 5 mm. long; **flowers** 2 mm. long, greenish yellow, in loose terminal panicles, sepals and petals five, stamens five; **fruit** a drupe, oblong, ovoid, or ellipsoid, 6-8 mm. long, with a two-celled stone.



Alabama supplejack

SOUTHERN WAXMYRTLE

Myrica cerifera L.

Southern waxmyrtle is one of the most common shrubs on longleaf pine-bluestem uplands west of the Mississippi River. On moist, unburned sites it may grow 40 feet tall, but such specimens are rare. Plants survive burning by resprouting vigorously from the root collar. Those burned periodically average about 3 feet high, forming large, many-stemmed clumps.

Leaves are 1 to 4 inches long, ¼ to ¾ inch wide, and broadest above the middle. The upper one-third is coarsely toothed; the base tapers to a point. The upper surface is darker green than the lower. Both surfaces are pitted with minute glands that often exude small globules of resin, visible under low magnification. Crushed leaves emit a distinctive camphorlike odor.

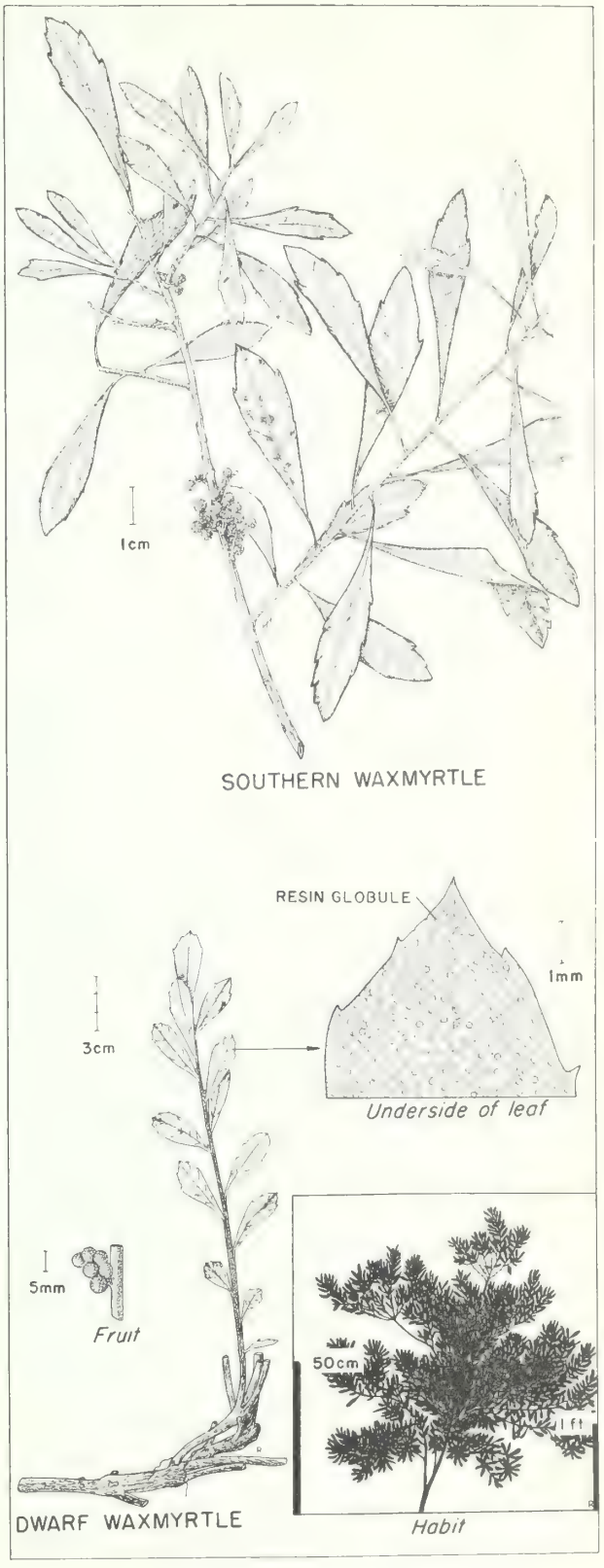
Male and female flowers are in inconspicuous catkins on separate plants. They appear in early spring, borne on last season's twigs. The nutlike fruits, about ⅛ inch in diameter, are coated with white wax. Many fruits persist through the winter.

Dwarf waxmyrtle, *Myrica pusilla* Raf., also grows throughout the longleaf pine-bluestem type. It is usually smaller than southern waxmyrtle, rarely exceeding 30 inches in height, and it spreads by rhizomes, often forming extensive colonies; southern waxmyrtle is without rhizomes. Despite these general differences, the two waxmyrtles are not always distinguishable by size and colonizing habit. Frequent burning and subsequent browsing may keep southern waxmyrtle to 30 inches in height or less, and cause plants to spread profusely. The two species can be differentiated in the field by leaf shape. Leaves of southern waxmyrtle taper gradually from the widest point toward the tip, whereas those of dwarf waxmyrtle taper abruptly.

Southern waxmyrtle is an evergreen. The old leaves are cast in the spring after initiation of new growth. Winter foliage contains about 10 percent protein. Where plants are kept low by periodic burning, cattle frequently browse the foliage during January and February. On unburned range, cattle and deer browse it sparingly. Although southern waxmyrtle is a secondary food plant for quail, the birds often consume much seed.

Range: Texas and Oklahoma to Florida and New Jersey.

Stems to 10 m. tall, spreading, with numerous resin-dotted branches; **leaves** simple, persistent, oblanceolate, alternate, aromatic, punctate, deep green and shining above, lighter beneath, entire or serrate above the middle, 4-9 cm. long, 0.5-2 cm. broad; **flowers** greenish brown to yellow in unisexual **catkins** on separate plants; **staminate flowers** axillary, ovoid, 6-12 mm. long; **pistillate flowers** linear, 5-10 mm. long, loosely flowered; **fruit** a spherical drupe, 3-4 mm. in diameter, covered with white-to-gray, waxy excrescences.



Southern waxmyrtle

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GLOSSARY

achene. A small, dry, one-seeded fruit with a tight, thin, indehiscent ovary wall.

acuminate. Tapering gradually to a point.

alternate. Leaves or other parts placed singly at different levels on a stem or axis.

annual. A plant that completes its life cycle in 1 year or less.

anther. The pollen-bearing part of the stamen.

anthesis. The period when anthers disseminate pollen or stigmas are receptive to pollen.

apetalous. Without petals.

apiculate. Ending abruptly in a short, sharp point.

appressed. Closely pressed against.

article. A section of a fruit, separated from adjacent sections by a constriction or joint.

attenuate. Tapering gradually.

auricle. An ear-shaped projection or appendage.

awn. A bristlelike appendage, often the extension of nerves or veins in floral bracts.

axil. The upper angle between an organ and the stem or branch to which it is attached.

barbellate. Finely barbed.

beak. A slender, pointed tip; sometimes double, appearing as an open, or gaping, beak.

berry. A fleshy, indehiscent fruit, with one to many seeds.

bipinnate. Twice pinnate.

blade. The upper expanded part of a leaf or petal.

bract. A reduced or modified leaf subtending a flower or flower cluster.

bracteole. A secondary bract, or bractlet.

bunchgrass. A grass that habitually grows in a well-defined tuft, as opposed to those spreading by long stolons or rhizomes.

caducous. Falling early.

callus. The hard, sharp-pointed base of certain grass fruits.

calyx. The sepals, collectively.

campanulate. Bell shaped, with a broad rim.

canescent. Coated with gray pubescence.

capillary. Hairlike.

capitate. Forming a dense or compact cluster; in heads.

capsule. A dry, dehiscent, usually many-seeded fruit, with two or more carpels.

carpel. A simple pistil, or a division of a compound pistil.

caryopsis. The fruit, or grain, of a grass.

catkin. A dry, scaly, pendulous spike, usually unisexual, commonly staminate.

caudex. The persistent base of an herb.

cauline. Attached directly to the main stem.

chaff. Small, thin scales or bracts, becoming dry and membranous.

ciliate. Fringed with marginal hairs.

ciliolate. Minutely ciliate.

collar. The outer area of a grass leaf where blade and sheath join.

compound. Composed of two or more similar parts.

cordate. Heart shaped; used primarily to describe leaf bases with heartlike lobes.

coriaceous. Leathery in texture.

corm. A bulblike, but solid, base of a stem, often subterranean.

corolla. The petals, collectively.

corymb. A flat-topped, indeterminate inflorescence, with outer flowers maturing first.

cremocarp. The dry, dehiscent, two-seeded fruit of plants in the family Umbelliferae.

crenate. With coarse, rounded teeth.

culm. The stem of a grass or sedge.

cuneate. Wedge shaped or narrowly triangular, with the point downward.

cyme. A flat-topped determinate inflorescence, with the central flowers opening first.

decumbent. Reclining, but with apices ascending.

decurrent. Pointing downward.

dehiscent. Opening at maturity by slits or valves to discharge the contents.

deltoid. Triangular.

dentate. Toothed, with sharp, spreading, coarse indentations perpendicular to the margin.

digitate. Handlike; compound, with members arising from one point.

dioecious. Bearing unisexual flowers, with the staminate and pistillate borne on different plants.

discoid. Having only disk flowers.

disk flower. The tubular, regular flowers crowded in the center of the flower head in Compositae, as distinguished from the outer, ligulate, ray flowers.

drupe. A fleshy fruit, with one or more hard seeds in the center.

ellipsoid. A solid, elliptical in outline.

emarginate. Shallow-notched at the tip.

entire. Without marginal teeth or lobes.

equitant. Leaves alternate in two ranks, each leaf overlapping the leaf above.

exserted. Projecting beyond; not included.

fascicle. A close cluster.

filiform. Threadlike.

fimbriate. Fringed.

flabellate. Fan shaped.

floret. A small flower, usually one of a dense cluster, in grasses and sedges; the unit of a spikelet.

forb. An herb other than a grass, sedge, or rush.

frond. The foliar part of ferns and fern allies, corresponding to a bipinnately compound leaf in flowering plants.

gamopetalous. With the petals at least partially joined together.

gamosepalous. With sepals united.

geniculate. Bent abruptly.

glabrous. Devoid of hairs.

glaucous. Whitened with a waxy bloom.

glomerule. A cyme condensed into a headlike cluster.

glume. A chafflike bract, subtending a grass spikelet.

habit. The general appearance of a plant.

head. A dense cluster of stalkless flowers.

herb. A plant that does not develop a persistent above-ground stem.

hirsute. Covered with long, stiff hairs.

hispid. Stiff, bristly pubescent.

hyaline. Transparent or translucent.

hypanthium. Floral cup formed by fusion of stamens, sepals, and petals.

imbricate. Overlapping, either spirally or vertically.

indehiscent. Not opening at maturity.

indument. Any hairy covering or pubescence.

indusium. Covering of a sorus.

inflorescence. The flowering part of a plant.

innovation. A basal shoot of a perennial grass.

internode. The part of the stem between two nodes or joints.

involucre. The whorl of leaflike bracts surrounding a flower or flower cluster at its base.

involute. With the margins rolled upward and inward.

irregular. Said of flowers with petals or sepals unequal in size or shape.

keel. The two lower, united petals of a papilionaceous legume flower. Also, the projecting midrib on the underside of a laterally compressed grass leaf.

lanceolate. Lance shaped; several times longer than broad, broadest below the middle and tapered toward the apex.

leaflet. A single division of a compound leaf.

legume. A plant of the family Leguminosae; the fruit or pod of such plants.

lemma. The lower, outermost of the two bracts of the grass floret.

lenticular. Lens shaped; biconvex.

ligule. In grasses a thin, membranous, hairy, or ridgelike appendage on the inside of the leaf where blade and sheath join; in composites the flattened, straplike corolla of the ray flowers.

liliaceous. Possessing characteristics typical of Liliaceae.

linear. Long and narrow, with parallel sides.

locule. One of the chambers in a compound ovary or in the fruit; also applied to the cavities of an anther.

loment. A legume fruit, flattened and strongly constricted between seeds, usually breaking at maturity into one-seeded segments or articles.

membranous. Parchmentlike.

-merous. A suffix indicating the number of parts present in each floral series; e.g., five-merous—a flower with 5 petals, 5 sepals, and 5 stamens.

midrib. The central vein of a leaf.

monoecious. Bearing only unisexual flowers, with the staminate and pistillate borne separately on the same plant.

mucronate. With a short, small, abrupt tip.

nectary. A small, nectar-secreting gland.

nerve. An unbranched, usually straight, vein or rib.

neuter. Without functional stamens or pistils.

node. A joint, especially of grass stems, giving rise to one or more leaves.

oblanceolate. Invert-lanceolate.

oblique. Slanting; attached at an angle.

obovate. Egg shaped with broadest portion at the top.

obovoid. A solid, obovate in outline.

obsolete. Rudimentary, or not evident.

opposite. At the same level, on either side of a stem or axis.

orbicular. Circular.

ovary. The enlarged base of the pistil that encloses the ovules and later ripens into the fruit.

ovate. Egg shaped in outline, and broadest below the middle.

ovoid. A solid, ovate in outline.

palea. The inner bract of the grass floret.

palmate. Arising from a common point, as the fingers of a hand; digitate.

panicle. A compound, indeterminate inflorescence of stalked flowers, with the longer, lower branches maturing flowers earlier than the short upper branches.

papilionaceous. Butterflylike; used to describe the irregular corolla in some members of Leguminosae.

papillose. Beset with tiny, pimplelike protuberances, or papillae.

pappus. A ring of plumose or capillary bristles, scales, spines, or teeth at the tip of the achene in Compositae.

pedicel. The stalk of an individual flower or fruit in a compound inflorescence.

peduncle. A flower stalk supporting either a cluster of flowers or a single-flowered inflorescence.

perennial. Producing above-ground parts from the same root system for at least three growing seasons.

perfect. Having functional stamens and pistil(s) in the same flower.

perianth. Collectively, the calyx and corolla.

perigynium. A flask-shaped sac enveloping the achene in *Carex*.

petal. One of the inner whorl of flower blades; a unit of the corolla.

petiole. The stalk by which a leaf, either simple or compound, is attached to the stem.

phyllary. A bract subtending the flower head in Compositae.

pilose. Covered with soft, straight, fine hair.

pinna. A main or primary division of a pinnately compound leaf.

pinnate. A featherlike arrangement; branches, leaflets, lobes, or veins arranged in one plane on two sides of a central axil; **even-pinnate**—with no single terminal leaflet, **odd-pinnate**—with a terminal leaflet.

pinnule. The secondary division of a bipinnate or tripinnate leaf or frond.

pistil. The seed-bearing organ of a flower, composed of stigma, style (when present), and ovary.

pistillate. Having functional pistil(s), but no functional stamens; female.

plumose. Having fine, elongate hairs in a single plane, on either side of a central axis; featherlike.

pod. A dehiscent dry fruit.

polygamodioecious. Polygamous, but predominantly dioecious.

polygamous. Bearing unisexual and perfect flowers on the same plant.

puberulent. Minutely pubescent.

pubescent. Covered with short, soft hairs.

punctate. Dotted with depressions, glands, or small colored spots.

raceme. A simple, elongate, indeterminate inflorescence, with stalked flowers.

rachilla. The axis of the spikelet in grasses and sedges.

rachis. The axis of an inflorescence or a pinnately compound leaf; the main axis of a fern frond.

radiate. Arranged around a common center; also said of flower heads in Compositae which bear ray flowers.

ranked. Arranged in rows.

ray flower. A marginal flower with straplike corolla, in the head of most Compositae.

receptacle. The enlarged or expanded axis, which bears either the organs of a flower, or the collected flowers of a head.

reflexed. Angled downward.

regular flower. A flower with all members of each whorl similar in shape and size.

reniform. Kidney shaped.

reticulate. Net-veined.

retrorse. Pointed backward or downward.

revolute. With margins rolled under.

rhizome. An underground stem, distinguishable from a root by its nodes, buds, and scalelike leaves.

rootstock. A rhizome, or underground stem.

rosette. A cluster of leaves radiating from a very short stem and growing close to the ground.

rotund. Round in outline.

rugose. Wrinkled.

sagittate. Shaped like an arrowhead, the basal lobes pointing downward or backward.

scabrous. Rough to the touch.

scale. A general term applied to a variety of small, usually dry, leaflike structures or bracts.

scape. A leafless flower stalk arising from an underground part.

scarious. Thin, dry, membranous, and not green.

secund. Arising, or apparently arising, from one side of an axis.

seed. A ripened ovule.

sepal. One of the outer whorl of flower blades; a unit of the calyx.

septate. Divided by partitions.

serrate. With sharp, forward-pointing teeth.

serrulate. Finely serrate.

sessile. Not stalked.

setaceous. Bristlelike, or bristle shaped.

setose. Having bristles.

sheath. The lower, tubular, stem-clasping part of leaves, especially in grasses, sedges, and rushes.

sinuous. Wavy.

sorus, pl. sori. A cluster of sporangia in nonflowering plants.

spathe. The sheathing bract of an inflorescence.

spatulate. Broad and rounded at the apex, with a short, narrowed base.

spike. A simple, elongated, indeterminate inflorescence with sessile flowers.

spikelet. The basic unit of the grass and sedge inflorescence, consisting of one or more florets and a pair of subtending glumes.

sporangium, pl. sporangia. A spore case of nonflowering plants.

squarrose. With spreading or recurved bracts or scales.

stamen. The pollen-bearing organ of a flower.

staminate. Having functional stamens, but no functional pistil; male.

standard. The upper, expanded petal of a papilionaceous flower.

stigma. The pollen-receiving tip of a pistil.

stipe. The stalk of a fern frond; also the stalk of a pistil or other small organ.

stipel. Small appendage at the base of the stalk supporting a leaflet.

stipitate. Having a stipe.

stipulate. With stipules.

stipule. One of a pair of small, leaflike appendages at the base of a leaf petiole.

stolon. A horizontal, above-ground branch or runner that roots at nodes.

striate. Having fine longitudinal lines, ridges, or channels.

strigose. With appressed, stiff hairs.

style. The usually elongate portion of the pistil, arising from the ovary and terminated by the stigma.

subglobose. Globe shaped, but slightly flattened.

subulate. Awl shaped; tapering gradually to a slender, rigid point.

symmetrical. Said of a regular flower having an equal number of petals, sepals, and stamens.

terete. Round in cross section.

throat. The junction of the tube and the expanded part of a united corolla; also the opening in a tubular corolla.

tiller. To produce basal sprouts from the root crown; also, the sprout produced by tillering.

tomentose. Densely woolly-pubescent.

tomentulose. Coated with a fine mat of woolly pubescence; finely tomentose.

trichome. Any hairlike outgrowth of the epidermis.

trifid. Split into three.

trifoliolate. Leaves with three leaflets.

trigonous. Three sided; triangular in cross section.

truncate. With the base or apex transversely straight, appearing cut off.

tuber. A short thickened, usually underground stem or shoot, with numerous buds ("eyes") in the axils of minute, scalelike leaves.

tubercle. A small tuberlike body or nodule.

turbinate. Inversely conical; top shaped.

umbel. A more or less flat-topped, indeterminate inflorescence, with pedicels and peduncles arising from a common point.

undulate. Wavy margined, or with a wavy surface.

unisexual. Of one sex; staminate or pistillate.

verticillate. A whorled, or apparently whorled, arrangement of leaves, inflorescence branches, flowers, etc.

vesture. A term applied to all types of hairiness or coatings on plant surfaces.

villous. Bearing long, soft hairs.

viscid. Sticky.

wing. One of a pair of lateral petals on a papilionaceous flower.

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Late Planting Improves Loblolly Survival

S. J. Ursic, H. L. Williston, and R. M. Burns

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Late Planting Improves Loblolly Survival

S. J. Ursic,[1] H. L. Williston,[2] and R. M. Burns[3]

Traditionally, loblolly pine is planted in the South between December 1 and March 1. By December 1, fall rains wet and soften the soil sufficiently for planting. The planting season ends when seedlings stop arriving from the nursery. This occurs before March 1 because seedlings must be lifted before they break top dormancy, and the beds must be prepared for the next crop. Thus schedules at the nurseries, most of them south of the planting areas, determine the end of the planting season, even though climatic and soil conditions at the planting sites are optimum for 1 to 2 months longer.

Planters had suspected higher losses among seedlings planted early in the season than among those planted later, but with large acreages to plant they needed a full 3 months, and considered such losses a part of the planting risk. The first solid evidence to confirm their suspicions came from surveys of survival started in 1955 on the huge Yazoo-Little Tallahatchie Flood Prevention Project. The surveys revealed a progressive increase in survival for plantings in December, January, and February (table 1). When compared to survivals of December plantings, those of January plantings were 2 to 8 percent higher in 6 years out of 9, and those of February plantings were 2 to 13 percent higher in 8 years out of 9.

This progressive increase implied that survival could be further improved by planting after March 1. In 1955 (study 1), it was established that seedlings could be stored as long as 5 weeks in standard Forest Service bales *(6)*, and the way was opened for field trials of March and April planting.

Seven subsequent studies between 1959 and 1963 explored the key variables. First, the maximum extension of the planting season was investigated. Then the additional factors—time of lifting, packaging method, storage method, storage duration, time of plant-

[1] In charge of the project on Coastal Plain Hydrology maintained by the Southern Forest Experiment Station at Oxford, Mississippi, in cooperation with the University of Mississippi.

[2] In charge of the project on Management of Erosive Watersheds, Southern Forest Experiment Station, Oxford, Mississippi.

[3] Silviculturist, Southeastern Forest Experiment Station, Marianna, Florida.

Table 1.—*First-year survival by month of planting, Yazoo-Little Tallahatchie Flood Prevention Project, in north Mississippi*

Planting season	Month planted		
	December	January	February
1954-1955	74	82	84
1955-1956	56	58	60
1956-1957	81	84	83
1957-1958	57	63	70
1958-1959	71	76	83
1959-1960	70	66	73
1960-1961	85	92	90
1961-1962	86	82	80
1962-1963	72	66	83
1963-1964		71	78

ing, and their interactions—were studied. Among the studies (table 2) some variables were necessarily confounded, and the results sometimes appeared conflicting, but the composite findings revealed unmistakably that extending the planting season is beneficial.

The studies and the conclusions drawn from them are described in this paper. Unless otherwise noted, 1-0 loblolly seedlings of grades 1 and 2, obtained from uniform sections of nursery bed sown with seed from a single source, were bar-planted on abandoned fields in the studies. Cold storage was at 33 to 35° F. with relative humidity exceeding 90 percent. Warehouse storage was in a shelter heated only when necessary to keep the seedlings from freezing.

Table 2.—*Variables investigated in each study*

Variables	Study number and year planted							
	1 1955	2 1959	3 1960	4 1959	5 1960	6 1961	7 1963	8 1963
Time of lifting				X	X			
Storage duration[1]	X	X	X	X	X	X	X	X
Time of planting	X	X	X	X	X	X	X	X
Storage methods	X			X	X	X	X	X
Packaging methods					X	X	X	
Sites			X					

[1] Variables connected by brackets are confounded, e.g., seedlings lifted, shipped, and stored at the same times and planted at varying intervals are affected by length of storage and time of planting; seedlings lifted at intervals and planted on one day are influenced by time of lifting and length of storage.

All studies were well replicated, and first-year survivals and height increments were statistically analyzed. Seedlings were grown at the U. S. Forest Service Ashe Nursery near Brooklyn, Mississippi (latitude 31), and were stored and planted near Oxford, Mississippi (latitude 34° 20′).

The studies are henceforth referred to by the numbers assigned them in table 2.

HOW LONG CAN PLANTING BE EXTENDED?

In study 2, Forest Service bales of 1,000 seedlings packed with sphagnum moss were held in cold storage or in a food-storage locker maintained at 44° F. with relative humidity exceeding 90 percent. Seedlings lifted in late January 1959 were planted on the 1st and 15th of each month from February through June.

Survival through the first growing season was excellent (79 percent or better) for all plantings from February 15 through June 1, but was substantially lower for seedlings planted on February 1 and June 15 (fig. 1). Seedlings planted on April 1 survived best (91 percent); the increase of 5 percentage points over the next best date was significant at the 0.01 level of probability. Growth decreased in the following order of planting: April, March, February, May, and June. Cold storage and storage at 44° F. were equally effective.

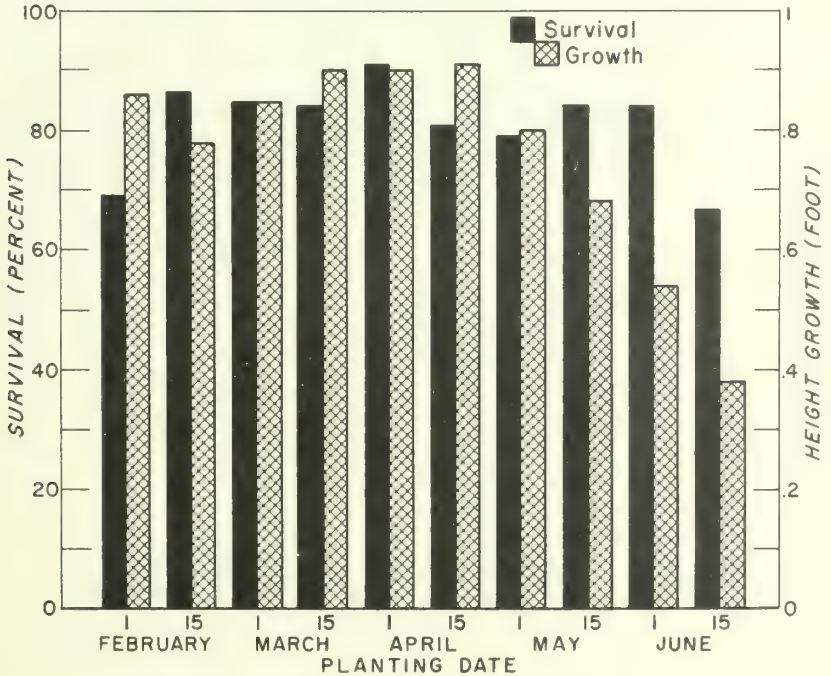

Figure 1.—*First-year survival and growth of cold-stored seedlings planted at biweekly intervals in 1959 (study 2).*

Study 3, installed the next year, was essentially a replication of study 2, except that all seedlings were held in cold storage. Seedlings lifted on January 5 were planted on abandoned fields and under scrub hardwoods at 2-week intervals starting January 19 and ending June 20. The hardwoods were girdled and poisoned in March.

First-year survival on the old fields fell off starting with the May 9 planting, but survival under hardwoods held up through the May 9 planting (fig. 2), probably because there was more moisture available late in the season under the deadened hardwood overstory than in the open. Seedlings planted in May and June grew least—probably in consequence of the shorter growing season.

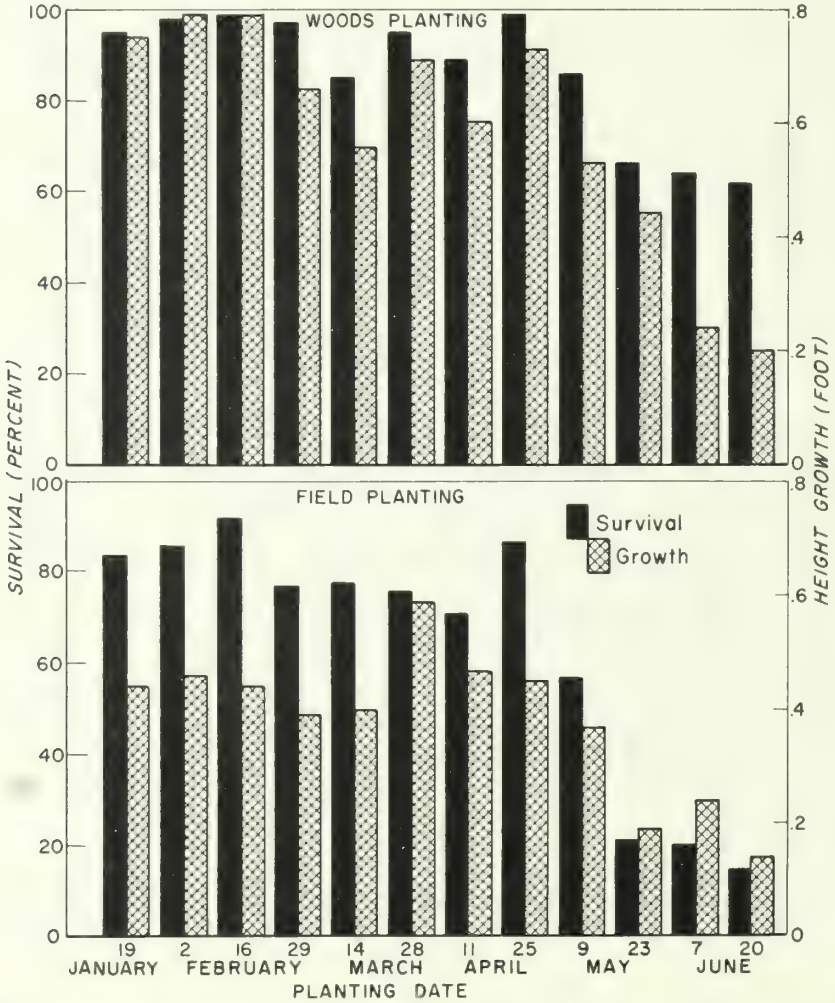

Figure 2.—*How cold-stored seedlings planted at biweekly intervals fared in 1960 (study 3).*

The combined results from studies 2 and 3 showed that cold-stored seedlings could be planted successfully for at least 2 months beyond the end of the usually accepted planting season. These results agreed generally with those reported by Yocom *(13)* from

an earlier test in northern Alabama, where survival of loblolly pine planted as late as May 1 was above 80 percent.

Planting cold-stored stock through March and April looked promising, but cold-storage facilities were not available in all communities. Planting administrators soon wanted to know if cold storage was really necessary. Would seedlings stored by alternate methods also maintain a high potential for field survival?

STORAGE METHODS

Study 4 compared the survival of seedlings packed in Forest Service bales and held up to 6 weeks in cold storage, warehouse storage, or buried in well-drained soil *(7)*. Bales on warehouse racks were watered every second or third day; those buried or in cold storage were watered on receipt from the nursery but not afterwards. Seedlings were outplanted on February 27 and March 13. The three storage methods were equally effective; survivals ranged from 91 to 95 percent.

Results from all studies combined show that cold storage is best, but the lack of such facilities does not preclude the advantages of extending the planting season. While cold-stored seedlings in five studies survived slightly better than seedlings stored in warehouses, excellent results were obtained from warehouse-stored seedlings planted as late as April 7, provided storage did not exceed 10 weeks. Table 3 compares survivals for the two storage methods after data for treatments demonstrated to be detrimental were deleted, i.e., lifting too early (study 5), packing with insufficient moss (study 6), and storing longer than 10 weeks (study 7).

Table 3.—*Survival of cold- and warehouse-stored trees*

Study No.	Survival		Maximum storage duration	Date of last planting
	Cold storage	Warehouse storage		
	– – Percent – –		*Weeks*	
1	95	93	5	February 28
4	95	93	6	March 13
5	86	80	9	April 7
6	98	98	9	April 7
7	88	92	10	March 20

Burying trees on planting sites has proved a practical alternative where neither cold storage nor shelters with watering and heating facilities are available. In a large-scale planting operation in northern Mississippi, more than a million seedlings were stored in earth pits in 1961 and 1962, with good results.

Study 8 tested refrigerator cars for seedling storage. They were found to be superior to warehouses in that daily temperature extremes were reduced and the hazard of freezing eliminated *(11)*. In the Yazoo-Little Tallahatchie Flood Prevention Project, 137 million seedlings were successfully stored in railroad cars during the 1961-66 planting seasons.

The studies show that storage method has little effect on first-year growth. Where growth differences were found, they did not exceed 0.10 foot.

Thus, the tree planter has at his disposal a satisfactory storage method to meet almost any circumstance. Cold storage is ideal, but warehouse storage is satisfactory. Refrigerated railroad cars are an excellent alternative, and burying in well-drained pits is satisfactory.

TIME OF LIFTING

The optimum lifting period, as measured by the ability of seedlings to survive storage and field planting, varies with changes in weather from year to year. Lifting between January 1 (preferably January 15) and February 15 is recommended for seedlings grown at the latitude of the Ashe Nursery. Lifting after February 1 will keep warehouse storage durations within safe limits when planting is extended through March.

The risk of seedlings deteriorating in storage militates against lifting in December. Seedlings in study 5, lifted on December 11, January 4, and February 2 in 1959-60, were planted after 1, 5, and 9 weeks of cold or warehouse storage *(8)*. Thus, planting was on five dates between December 17 and April 7.

An extended cold spell following the planting on February 11 greatly influenced survival. Subfreezing lows occurred on 25 of the next 33 days. Losses were greatest for December-lifted trees, particularly for those stored for 9 weeks (fig. 3). Seedlings planted on December 17 and January 14 were less affected by the cold, possibly because they had additional time to become adjusted to their new environment. Survivals of the March and April plantings, which missed the cold spell, were uniformly high. Survival of seedlings lifted in December, January, and February averaged 68, 81, and 86 percent, respectively. Growth was poorest for December-lifted trees and best for those lifted in February.

Kahler and Gilmore *(2)* reported the hazard inherent in December lifting in southern Illinois. They found that the survival of loblolly was materially reduced when seedlings were lifted in early December and outplanted after 4 months in cold storage. This they attributed to seedlings not being fully hardened off when lifted.

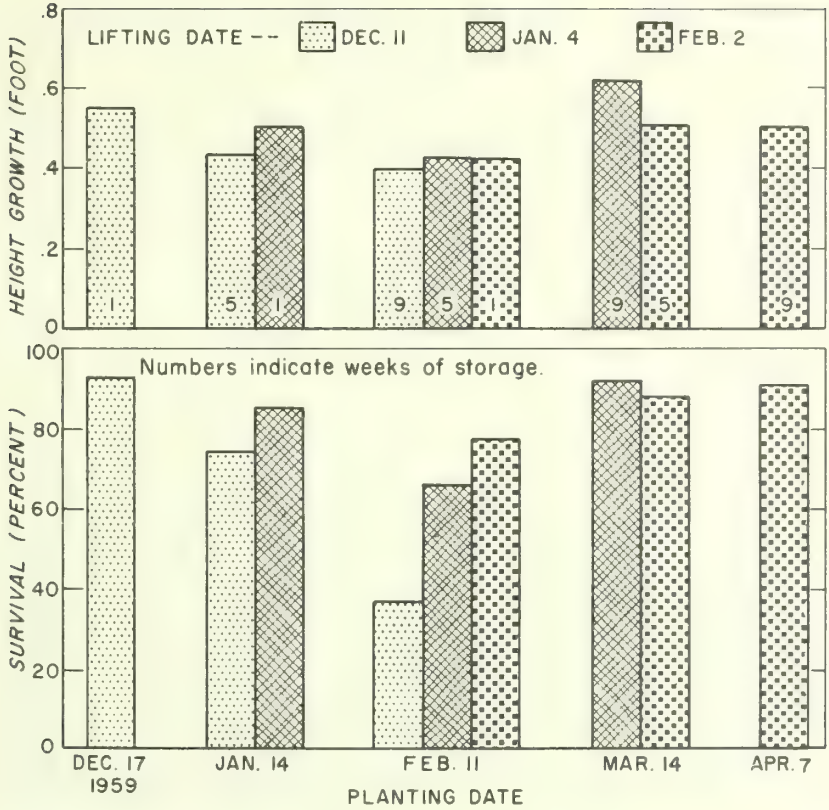

Figure 3.—*How time of lifting and length of storage affected the survival and growth of seedlings in study 5.*

Results regarding late-season lifting are conflicting, but there are sufficient reasons to avoid the practice. In study 4 seedlings were lifted on January 27, February 10, and February 17, 1959. The stock lifted on February 17 did not survive as well as the seedlings lifted earlier and stored longer (table 4). The implication was that seedlings to be stored should be lifted before they increase their physiological activity, perhaps even before overt bud development.

Table 4.—*How time of lifting affected first-year survival and growth (study 4)*

Lifting dates and storage durations	Survival	Growth
	Percent	*Foot*
January 27		
4 weeks	94	0.80
6 weeks	97	.81
February 10		
2 weeks	98	.68
4 weeks	98	.63
February 17 [1]		
1 week	89	.72
3 weeks	84	.66

[1] Date of last shipment from nursery.

In a phase of study 6, high survivals of seedlings lifted on February 28 and planted after 1 week (97 percent) and 5 weeks (93 percent) suggested that seedlings with actively growing tops could be held successfully in cold storage. Even so, earlier lifting, while the seedlings were still dormant, would have been preferable. Unless carefully handled, the new tops were easily damaged or broken (fig. 4), and exposure of the roots for varying periods before planting demonstrated that their potential for field survival was lower than for seedlings that had not flushed *(8)*. In another study in the same year *(3)*, seedlings lifted in late February survived as well (98 percent) as dormant seedlings planted earlier, but the flush was killed back by March frosts. Then too, experience has shown that seedlings lifted near the beginning and end of the usual planting season are more likely to heat during transit and storage.

Figure 4.—*Fully dormant seedlings survive transportation, storage, and hard freezes better than those lifted after they have resumed growth.*

PACKAGING METHODS

Late planting requires that seedlings be stored. Studies 5 through 8 investigated packaging requirements as related to the type and duration of storage.

Seedlings in Kraft-polyethylene (K-P) bags packed with or without moss can be held in cold storage for at least 3 months. For more than 4 weeks of warehouse storage or storage after March 15, they should be packed with moss. Three to 5 pounds of damp moss

well distributed among the roots is sufficient. The K-P bags are sealed and need not be watered *(8, 12)*.

Forest Service bales packed with moss can also be held in cold storage for 3 months without special attention; those stored in warehouses should be watered twice a week.

With either type of packaging, warehouse storage should be limited to 8 weeks.

These recommendations are conservative in light of the excellent field performance of seedlings stored for longer periods, but they have a sound basis. In study 6, roots of seedlings packed in K-P bags without moss or with 10 pounds of moss were exposed for 20, 60, and 120 minutes before planting after 1, 5, and 9 weeks of warehouse storage *(8)*. Survival and growth of these seedlings decreased linearly with increasing duration of storage, and those packed with moss had a greater tolerance to exposure than those packed without moss. This test made it possible to assess the condition of seedlings and their potential for field survival, even though the seedlings survived when planted under favorable field conditions.

Between 1961 and 1966, 142 million seedlings were stored in K-P bags in northern Mississippi. Difficulties, which were few, were the result of deviations from prescribed procedures for packing, shipping, and storage *(9)*.

RECOMMENDED PLANTING SEASON

Uniformly high survivals attest to the success of late plantings. Survivals exceeded 90 percent in five of the eight studies, and ranged from 83 to 88 in the others. These averages include values for treatments shown to be injurious. They also include losses associated with severe cold to which seedlings are particularly vulnerable soon after planting. In study 8, for example, the January plantings were hit by severe cold and both survival and growth were greatly reduced (table 5).

Table 5.—*How date of planting affected the performance of loblolly seedlings planted following refrigerator-car storage (study 8)*

Date of planting	Storage duration	First-year survival	Total height of seedling after first growing season
	Weeks	*Percent*	*Feet*
January 18	1	79	0.90
February 15	5	93	1.18
March 15	9	99	1.50

Survival and growth of March and April plantings consistently ranked among the highest. Damaging cold weather may occur any time in January, February, or March, but the risk is decreased with

each week the planter can delay and still complete his planting during April.

Findings of other studies support the contention that risk is decreased by planting late. Loblolly root activity was found to be at a minimum when soil temperature was below 39 to 41° F., both under greenhouse conditions *(1)* and in 6-year-old stands *(4)*. In northern Mississippi over a 7-year period, silt and sandy loams warmed to this extent between January 15 and March 24. Seedlings planted before the soil is warm enough for root growth are simply stored in the ground until the soil temperature increases. They are better stored in packages in a cold, moist environment. In storage they are not exposed to frosts, frozen soils, and animal damage, and after planting they are less subject to soil washing by winter rains, the principal cause of mortality on bare soils *(10)*.

The extent of the planting season is governed by the time needed for planting and by storage facilities. For areas with climate similar to that in northern Mississippi, the following dates are recommended:

Storage facility	Packing method	Recommended planting dates [1]
Cold	Forest Service bales; K-P bags with or without moss	January 15 to April 15
Warehouse	Forest Service bales watered biweekly; K-P bags packed with moss (limit storage to 8 weeks)	January 15 to April 1
	K-P bags packed without moss (limit storage to 4 weeks)	January 15 to March 15

Planters not requiring a full 3-month season can profit by starting later than the dates shown. Those who need a full 3 months can benefit by delaying until January 1 without incurring additional costs or sacrificing part of the season. With the slight additional cost of cold storage, it is possible to delay the start of planting and still lengthen the present 3-month season (December 1 to March 1) by 2 to 4 weeks.

AREA OF APPLICATION

Late planting is advantageous wherever severe winter temperatures occur and spring rainfall is favorable for seedling establishment.

[1] The latter half of each interval is preferred. Where additional time is required, cold stored seedlings can be planted 2 weeks earlier and 2 weeks later than the dates shown.

These factors were considered in delineating a zone within which study results should be applicable.

The zone includes all of loblolly's range in Oklahoma, Texas, Arkansas, Tennessee, Mississippi, Alabama, Georgia, and North and South Carolina north of latitude 33° (fig. 5). Long-term monthly mean temperatures from December through April within this zone are not more than 3° F. higher than those of the study area. The southern limit coincides roughly with the lower boundary of a zone that has an average annual minimum temperature of 15° F. *(5)*.

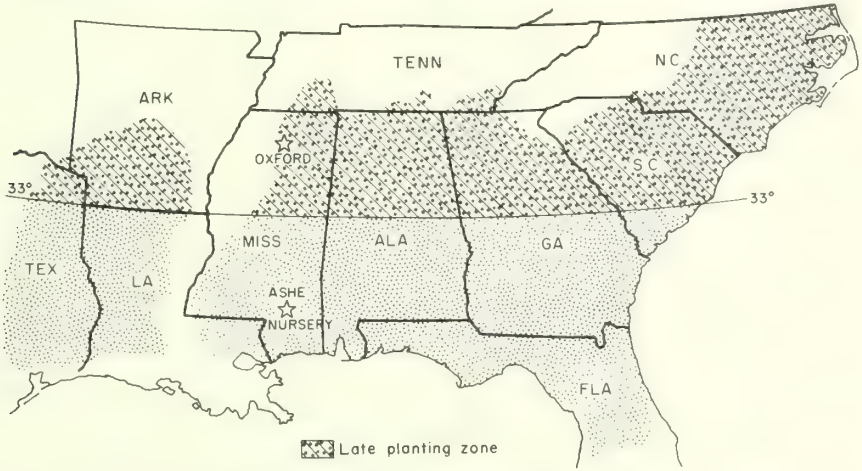

Figure 5.—*Area where late planting is recommended. Lightly dotted area shows the range of loblolly pine south of the late planting zone.*

Rainfall is favorable throughout the recommended area. Long-term means exceed 4 inches for each of the months March, April, and May in Oklahoma, Texas, Arkansas, Tennessee, and Mississippi. May rainfall in Alabama and Georgia is only slightly less (3.5 to 4 inches), and rainfall for each of the 3 months is 3 to 4 inches in North and South Carolina. For a particular locality, the planter should consult long-term local records.

Presumably, extending the season at least through March would be feasible even further afield. For example, a large area south of the recommended zone remains too wet for satisfactory planting during the normal planting season.

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STRAIGHT STUDS

FROM SOUTHERN PINE VENEER CORES

Peter Koch

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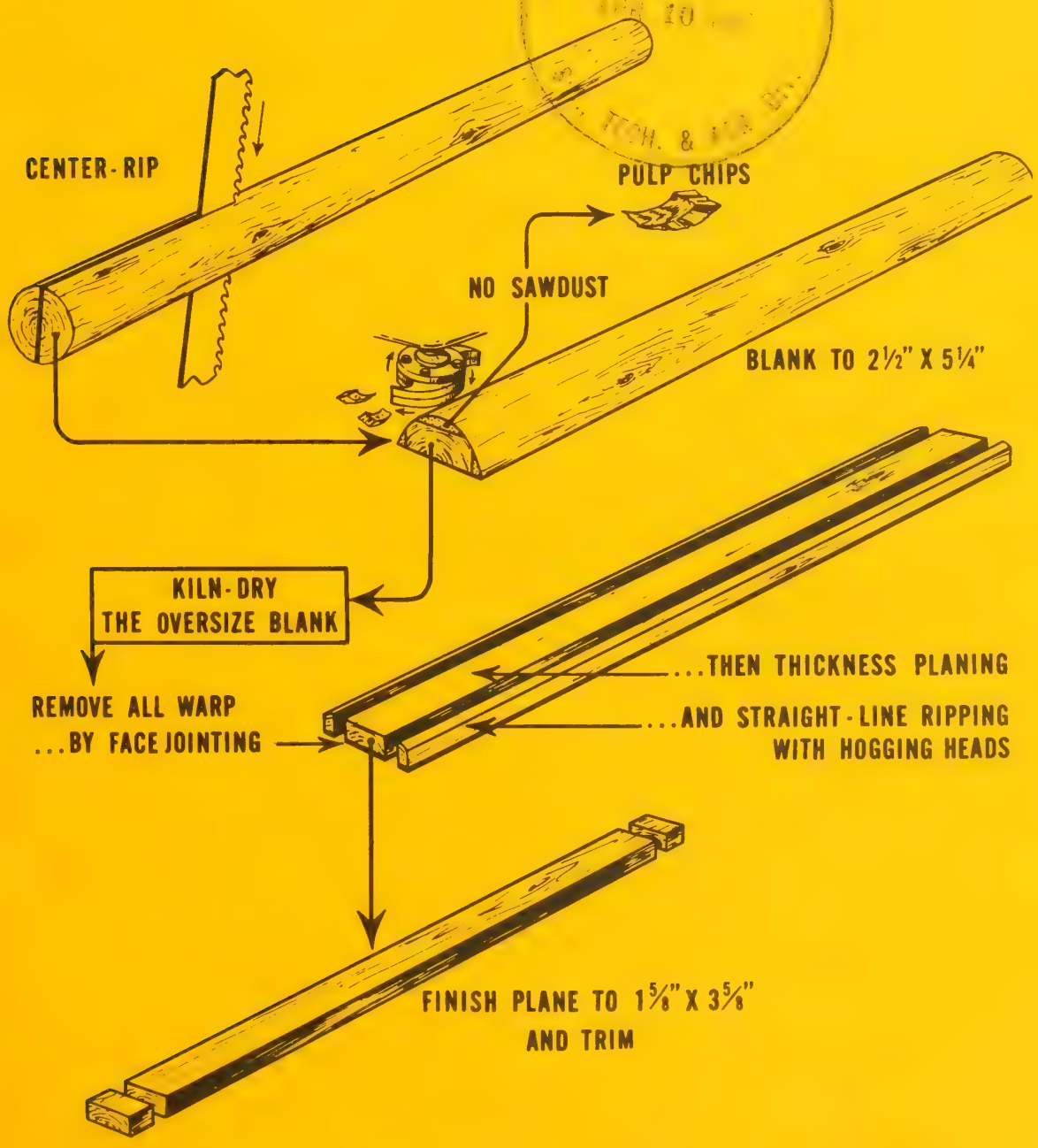

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U. S. FOREST SERVICE RESEARCH PAPER SO-25 1966

STRAIGHT STUDS

FROM SOUTHERN PINE VENEER CORES

Peter Koch

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

SUMMARY

This paper describes the development of a manufacturing method for converting southern pine veneer cores into straight 8-foot 2 by 4's. The research was in five phases: (1) conversion by conventional skrag mill, (2) comparison of six other manufacturing methods, (3) evaluation of post-machining coatings to control crook and moisture content (MC), (4) strength measurements on full-length studs, and (5) assessment of commercial feasibility.

Conversion by skrag mill.—Two hundred and forty-eight southern pine veneer cores averaging 5.3 inches in diameter were processed through an end-dogging skrag mill, cross-circulation kiln, and crook-reducing planer into pairs of S4S 2 by 4's 8 feet long. Ninety-one percent of the studs were SPIB Stud grade or better. The cores averaged 5.7 rings per inch; if they had been a more representative 3.5 rings per inch the yield of Stud grade and better would have been about 84 percent. Crook was minimized if specific gravity was low and if the pith was centered in the stud or located adjacent to a 3-5/8-inch face.

Comparison of other manufacturing methods.—Of six alternatives to skrag mill conversion, three produced studs that graded 100-percent SPIB Stud or better and suffered little distortion with changes in relative humidity (RH). In the simplest method (proposed, with modifications, for commercial practice) veneer cores were center-ripped, dried, fully jointed on the flat face, thicknessed, and finally straight-line ripped to finished width. In a second method, two edges of studs thus made were grooved to receive 8-foot glued inserts. In a third, the dry, rough half-core was crosscut at midlength, and each 4-foot section was facejointed and fingerjointed to a similar section from a different core; the 8-foot piece was then facejointed, thicknessed, and ripped to width.

Post-machining treatments to control crook and moisture content.—In suppressing crook, seven brush or dip treatments were equally ineffective. Although two brush coats of aluminum paint or shellac somewhat diminished rate of water pickup, even these treatments permitted major changes in MC during 8 weeks of exposure. Change in MC was positively related to change in crook. Rate of MC change in studs exposed under a water shower was inversely proportional to specific gravity and rings per inch. Studs with high specific gravity or many rings per inch were prone to crook.

Strength properties.—One hundred and five studs manufactured from the veneer cores had lower specific gravity (0.50 based on ovendry volume and weight), fewer rings per inch (3.6), and lower moduli of rupture and elasticity than studs from the normal run of logs.

Ultimate strengths (35 studs evaluated in each test mode) averaged 5,200 p.s.i. in edgewise bending, 4,830 p.s.i. in full-length compression, and 2,860 p.s.i. in full-length tension. Corresponding values for modulus of elasticity (MOE) were 1,310,000; 1,170,000; and 1,320,000 p.s.i. Yield strength was 72 percent of ultimate strength in bending and in tension but only 56 percent in compression.

Stiffness and strength of the 2 by 4's declined as SPIB grade decreased. MOE was positively correlated with full-length strength, but in no case accounted for more than 39 percent of the variation in ultimate strength. The studs were extremely variable because they had been manufactured by seven processes.

For reasons not clear, no test mode showed significant correlation between specific gravity and MOE. Simple regression analysis disclosed that MOE (measured by any test mode) was positively correlated with rings per inch (r^2 values from 0.27 to 0.37).

Commercial feasibility.—For an estimated $300,000 an existing plywood plant could be equipped to manufacture kiln-dry studs from cores. Annual production would be 10,752,000 board feet of studs if the lathe produces two 8-foot cores per minute and operates three shifts per day, 7 days per week, 50 weeks per year. Two man-hours of labor would be required per thousand board feet of studs. Total investment, including working capital, is estimated at $400,000. Annual sales would be $864,000, and annual profit before income taxes is estimated at $454,000. These figures are based on a purchase price of $0.212 per core (i. e., the alternative value of the core converted to chips at $6.30 per ton), a net sale price of $5 per ton FOB plant for dry wood waste, and an average net selling price of $75 FOB mill per M board feet of kiln-dry S4S studs.

STRAIGHT STUDS
FROM SOUTHERN PINE VENEER CORES

Southern pine plywood plants find themselves with large numbers of cores as a by-product from their 8-foot lathes. A typical core measures 5.3 inches in diameter and 8 feet 8 inches long, and weighs 70 pounds when green.

The cores are made at an approximate rate of two per minute per lathe. Therefore, a plant with one 8-foot lathe operating three shifts accumulates as many as 2,880 cores per calendar day. Usual practice is to convert the cores to pulp chips; at current prices, chips from a core are worth about $0.21. Alternatively, a core can be manufactured into two 8-foot studs that, together with pulp chips and dry residues, can be sold for about $0.86. The increased value of $0.65 per core amounts to a gross increase in revenue of $1,872 per operating day. Daily output of studs from a three-shift operation would total approximately 30,000 board feet.

Unfortunately, the cores contain a high proportion of juvenile wood and considerable compression wood. Furthermore, when two 2 by 4's are cut from one core, the piths are almost certain to be located unsymmetrically and close to one face. These circumstances all combine to cause instability and warp.

Research at the Southern Forest Experiment Station's Utilization Laboratory at Alexandria, Louisiana, has developed what appears to be an economically feasible method of manufacturing straight studs from cores. The work was performed in five phases. The first two dealt with manufacturing methods, and the third with the possibility of applying post-machining treatments to control MC and crook. The fourth study evaluated the strength of studs manufactured by various methods, and the fifth assessed the economic potential of the most promising method.

CONVERSION BY SKRAG MILL

The initial study evaluated twist, bow, and crook in 8-foot studs sawn in pairs from veneer cores. The Vancouver Plywood Company, Inc., Oakdale, Louisiana, furnished the cores. Facilities of the Southern Pine Superior Stud Corporation, Roxie, Mississippi, were employed to make the 2 by 4's.

PROCEDURE

A total of 248 green veneer cores, principally of loblolly pine, *Pinus taeda* L., grown in central Louisiana, were double-end trimmed to 8 feet 2 inches and sawn on an end-dogging skrag mill into round-edge cants 4-1/16 inches thick. The cants were then split into two 1-7/8-inch-thick studs on a three-saw edger with 5/32-inch kerf. Cores and studs are illustrated in figure 1.

A total of 489 studs were recovered from the 248 cores. As one was broken at the kiln stacker, the total from the green chain was 488. Because the cores averaged 5.3 inches in diameter, considerable wane was evident on the 2 by 4's.

Twenty-six of the rough green studs were lettered A to Z, weighed on a platform scale

Figure 1.—
The southern pine veneer cores and studs sawn from them.

(range in weight was 17 to 28 pounds), and reintroduced at intervals of 20 studs into the kiln charge. All studs were stacked on the bottom of a 7M kiln charge, and dried on a 5-day schedule in a cross-circulating kiln:

Dry bulb	Wet bulb	Hours
° F.	° F.	
165	140	24
Stepwise transition to next setting		12
190	160	33
200	180	12
200	170	15
200	194	24 (conditioning)

After drying, the lumber remained on sticks for 2 days in a cooling shed.

Evaluation of Rough Dry Studs

Studs not previously marked were numbered from 1 to 461 (the 462nd was broken in transit). Crook (the curvature of the 1-5/8-inch edge) and bow (the curvature of the 3-5/8-inch face) were measured by placing each stud on a flat gage table and measuring the maximum distortion with a scale graduated in hundredths of an inch. Twist was measured by holding three corners of the stud in contact with the gage table and measuring the elevation, above the table, of the fourth corner.

The studs lettered A to Z were weighed, then reweighed after ovendrying to permit calculation of green and kiln-dry moisture contents.

Evaluation of Planed Studs

Numbered studs were machined S4S on a planer equipped with a crook reducer, then graded by SPIB rules and tallied. Within 10 to 15 days of planing, the weight, twist, crook, and bow of each stud were recorded. All were then carefully stacked with sticks in a building controlled at 72° F. and 50 percent RH.

After 6 weeks on sticks, the lumber reached approximate equilibrium moisture content (EMC), and the weight, crook, twist, and bow were again recorded.

Ovendry weights and specific gravity were calculated from determinations made on 2-inch cross-sectional slices from ends of all studs. Rings per inch were measured on these same slices.

Pith position (both ends of stud considered) was recorded (fig. 2).

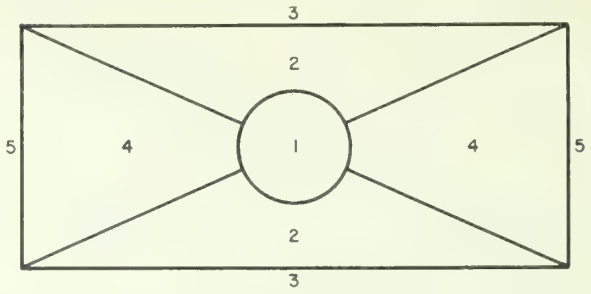

Figure 2.—*Pith positions: (1) centered within a ¾-inch-diameter circle; (2) adjacent to face but within the stud; (3) adjacent to face but outside stud; (4) adjacent to edge but within the stud; (5) adjacent to edge but outside of stud. In addition to those diagrammed two others were recognized: (6) angling face to face; and (7) angling edge to edge.*

Fifty studs (numbers 1 through 50) were then placed outdoors in a solid pile about 8 studs wide and 6 high. They were left exposed to sun and rain from November 10 to December 1, 1965. Average outside humidity was approximately 75 percent. Average daily maximum temperature was 76° F. Rain totaled 0.9 inch in three widely separated storms. Weight, crook, twist, and bow were recorded after the 3-week period.

Moisture content of the rough green studs designated A to Z averaged 81.5 percent and ranged from 43 to 132 percent. After cooling, the same 26 rough kiln-dry studs averaged 10.5 percent and ranged from 9.1 to 12.8 percent.

Following planing and 6 weeks on sticks at 50-percent RH, studs 51-461 reached an approximate EMC of 9.4 percent, with standard deviation of 0.49 percent.

GRADE YIELD

By SPIB rules, each of the three top grades of studs is limited to certain maximum distortions, as shown in columns 4, 6, and 8 of table 1. The two upper grades require a minimum of four rings per inch; a stud with less than this number of rings can qualify for Stud grade if it meets straightness standards somewhat more stringent than those for higher grades.

Ninety-one percent of the studs in this study graded Stud or better (table 1). Most of the

Table 1.—*Grade yield of studs from veneer cores, and average distortions [1] by grade*

Grade	Yield	Crook		Bow		Twist	
		Observed	Allowable	Observed	Allowable	Observed	Allowable
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Percent	*Inch*	*Inch*	*Inch*	*Inches*	*Inch*	*Inch*
SPIB 1	33	0.089	0.281	0.133	0.844	0.076	0.375
SPIB 2	35	.114	.375	.149	1.125	.097	.500
SPIB Stud	23	.103	.188	.157	.563	.120	.250
SPIB 3 (with No. 2 crook limits)	3	.268	.375	.367	1.688	.066	.750
Cut back shorter than 7'8"	1	.100		.120		.040	
Cut-up grade	3	.228		.202		.064	
Rip stock for 2 by 3's	2	.173		.285		.093	

[1] Distortion measured 10-15 days following S4S planing and grading of the kiln-dry studs.

remaining 9 percent were disqualified by warp. In a chi-square analysis, the grade yield from the cores was significantly better (0.005 level) than that obtained from the usual run of logs cut at the mill. The cores averaged 5.7 rings per inch; subsequent sampling indicated that mill-run cores probably average less than this amount—3.5 rings may be more representative. The difference would reduce the percentage yield of Stud grade and better, because it would cut down on the proportion of No. 1 and No. 2 and some of the fall-down would fail to meet the more stringent warp limitations of the Stud grade.

In the study, and probably in general practice as well, crook is a more frequent cause of degrade than bow or twist. It can be observed from table 1, column 4, that the crook limitation for Stud grade is 3/16 inch. Therefore the optimum conversion system must be capable of manufacturing all studs with less than 3/16-inch crook.

The table also indicates the average distortions, by grade, in the experimental studs. In the three top grades, crook averaged about 0.1 inch, bow 0.15, and twist 0.1.

Crook, Bow, and Twist as Affected by Stage of Manufacture

Averages of crook, twist, and bow are compared in table 2. For the 411 studs in the main experiment, planing S4S reduced (0.01 level

Table 2.—*Distortion of studs at several stages of manufacture [1]*

Stage of manufacture	MC	Crook		Bow		Twist		Specific gravity [2]
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Percent	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	
Studs 51-461								
Rough green	[3] 81.5	.	..	.	.	.	.	.
Rough kiln-dry [4]	[3] 10.5	0.16	0.135	0.17	0.106	0.15	0.103	.
S4S kiln-dry [5]	11.1	.11	.087	.15	.132	.09	.075	.
S4S at EMC [6]	9.4	.15	.139	.19	.161	.12	.097	0.54
Studs 1-50								
Rough green	[3] 81.5	.	.	.	.	.	.	.
Rough kiln-dry [4]	[3] 10.5	.18	.	.18	.	.13	.	.
S4S kiln-dry [5]	11.8	.11	.	.17	.	.10	.	.
S4S at EMC [6]	9.6	.13	.	.17	.	.08	.	.56
S4S in exterior pile [7]	10.5	.12	.	.15	.	.08	.	.

[1] Data are divided into two groups: studs 1-50, subjected to exterior exposure; and studs 51-461, not subjected to exterior exposure.
[2] On basis of ovendry weight and ovendry volume.
[3] Twenty-six sample studs only. See Procedure.
[4] Measured September 1, 1965, following 2 days in cooling shed.
[5] Measured in Alexandria, Louisiana, September 10-15, 1965, i. e., 10-15 days after being planed S4S in Roxie, Mississippi, on a crook-reducing planer.
[6] Measured October 22-27, 1965, after 6 weeks of conditioning on sticks in atmosphere controlled at 50 percent RH and 72° F.
[7] Measured December 1, 1965, after 20 days of exterior exposure in a solid pile.

of significance) average crook from 0.16 inch to 0.11; reduced average bow from 0.17 inch to 0.15; and reduced average twist from 0.15 inch to 0.09.

When the studs were stacked at 50 percent RH until they reached 9.4 percent EMC, they developed significantly more distortion than they had when they left the planer. Average crook increased from 0.11 inch to 0.15, average bow from 0.15 to 0.19, and average twist from 0.09 to 0.12.

When studs 1-50 were piled outdoors for 3 weeks, they reached an average MC of 10.5 percent, with standard deviation of 1.50 percent. As this was intermediate between their S4S kiln-dry MC (11.8 percent) and their EMC at 50 percent RH (9.6 percent), the distortion was also intermediate (table 2).

The tabulation below shows maximum warp values, in inches, among the 411 studs:

	Crook	Bow	Twist
Rough kiln-dry	1.45	0.91	0.70
Soon after planing	1.08	1.25	.44

When the 11 worst studs in each distortion class were rejected, maximum values were considerably reduced:

	Crook	Bow	Twist
Rough kiln-dry	0.60	0.41	0.37
Soon after planing	.32	.48	.25
At EMC S4S	.54	.58	.35

When measured after planing, 403 studs, or 98 percent, had warp equal to or less than the 0.375-inch crook, 1.125-inch bow, and 0.500-inch twist permitted by SPIB No. 2 grade. As only 68 percent were actually graded No. 2 and better (table 1), it is evident that knot structure, wane, or low ring count caused 30 percent to be graded Stud or worse.

If measured when rough kiln-dry, the 411 studs displayed little correlation between crook and bow ($r = 0.299$) or crook and twist ($r = -0.203$). Bow and twist were not correlated.

Pith Location

Crook, bow, and twist were all significantly affected by location of pith (fig. 2, table 3). When warp values for the initial three stages of manufacture are averaged, the following conclusions may be drawn regarding the 461 studs:

(1) Pith position *2* yielded low average crook (0.12 inch) and bow (0.16), but maximized twist (0.14).

(2) Pith position *5* minimized average twist (0.03), but maximized crook (0.24), and bow (0.22).

(3) In terms of effect on crook and bow, pith positions *1*, *2*, and *3* were superior to pith positions *4* and *5*.

(4) In terms of twist, pith positions *3*, *4*, and *5* were superior to pith positions *1* and *2*.

(5) Pith positions *6* (angling face to face) and 7 (angling edge to edge) appeared to yield low average values of crook (0.11), bow (0.12), and twist (0.08).

Table 3.—*Average crook, bow, and twist of studs according to pith location and stage of manufacture*

Pith position [1]	No. of studs	Rough kiln-dry studs			Measured S4S 10-15 days after planing			Measured S4S after 6 weeks of conditioning on sticks at 50 percent RH		
		Crook	Bow	Twist	Crook	Bow	Twist	Crook	Bow	Twist
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
1	19	0.154	0.167	0.133	0.137	0.126	0.090	0.195	0.208	0.134
2	192	.140	.159	.168	.104	.142	.111	.124	.171	.136
3	185	.178	.179	.136	.117	.164	.082	.165	.199	.092
4	43	.197	.193	.131	.133	.211	.083	.176	.264	.113
5	5	.294	.124	.024	.156	.258	.032	.260	.292	.036
6	14	.130	.146	.106	.100	.106	.075	.118	.136	.057
7	3	.110	.100	.083	.093	.103	.090	.113	.123	.090
Significance [2]		**	N. S.	***	N. S.	**	***	**	**	***

[1] See figure 2.

[2] By variance analysis of distortion as related to pith location: ** indicates significance at 0.01 level; and *** at 0.005 level.

It should be observed that few of the 461 studs had pith positions 5 (5 studs), 6 (14 studs), and 7 (3 studs).

Specific Gravity

In studs 51-461, specific gravity was positively related to rings per inch (fig. 3). Specific gravity (ovendry volume and weight) of individual studs ranged from 0.86 to 0.37 and averaged 0.54; standard deviation was 0.083.

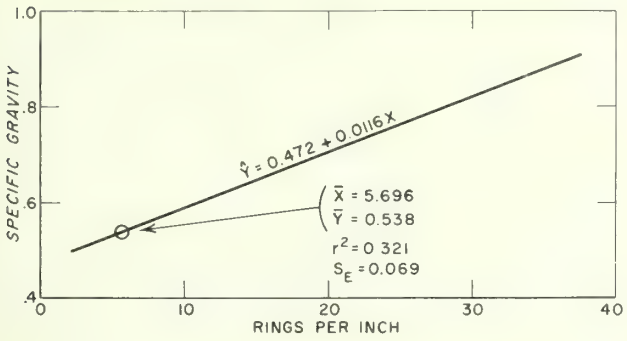

Figure 3.—*Regression of specific gravity (ovendry volume and weight) on growth rate (rings per inch) for studs 51-461. Relationship is significant at 0.005 level.*

Crook displayed a weak positive relationship to specific gravity (fig. 4). However, twist was negatively related to specific gravity (fig. 5). Bow displayed no significant relationship to specific gravity. Thus, with increasing specific gravity, crook became more severe and twist less severe, while bow was unaffected.

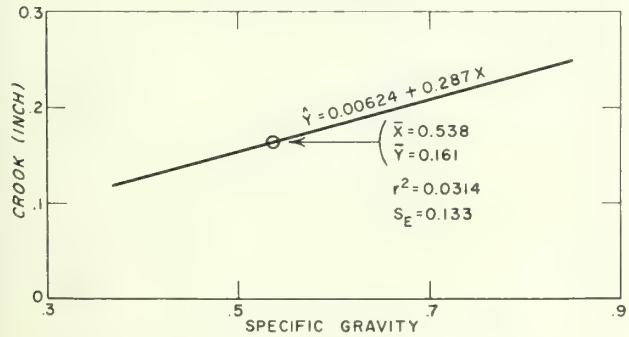

Figure 4.—*Regression of crook in rough, kiln-dry studs 51-461 on specific gravity (ovendry volume and weight). Relationship is significant at 0.005 level.*

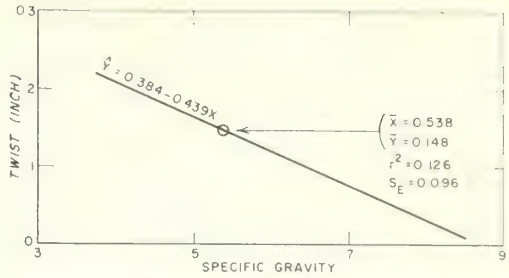

Figure 5.—*Regression of twist in rough kiln-dry studs 51-461 on specific gravity (ovendry volume and weight). Relationship is significant at 0.005 level.*

Growth Rate (Rings per Inch)

Growth rate was not related to crook or bow, but had a significant (0.005 level) negative relationship to twist (fig. 6). Growth rate ranged from 2 to 37 rings per inch and averaged 5.7 (standard deviation 4.06 rings per inch). Of the 411 studs, 400 had fewer than 17 rings per inch.

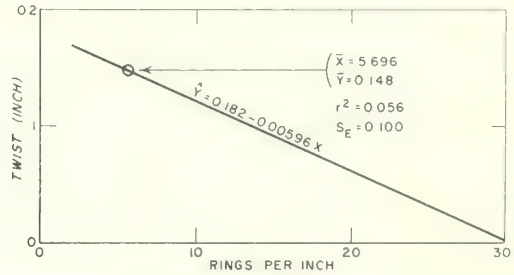

Figure 6.—*Regression of twist of rough kiln-dry studs 51-461 on growth rate. Relationship is significant at 0.005 level.*

CONCLUSIONS

On the basis of this limited sample, it would appear that southern pine veneer cores contain wood of sufficient quality to produce paired 2 by 4's with an acceptable percentage of Stud grade and better (in this case, 91 percent).

Crook, the major defect, was minimized if:

(1) The pith was located inside the stud and adjacent to the 3-5/8-inch face. (This location, unfortunately, maximized twist.)

(2) The studs were of relatively low specific gravity. (But studs of low specific gravity twisted more than those of high specific gravity.)

(3) The rough studs were planed on a crook-reducing planer.

(4) The MC of the studs subsequent to planing remained unchanged from that at time of planing.

COMPARISON OF SEVEN CONVERSION METHODS

Eight-foot S4S dry studs were manufactured from southern pine veneer cores by seven conversion processes and evaluated for grade and warp—both the warp present immediately after machining and that induced by changes in RH. The conversion processes are diagrammed in figure 7:

(1) Studs sawn from cores on skrag mill, kiln-dried, and finished on crook-reducing planer.

(2) Round cores (fig. 8) dried to more or less uniform MC in atmosphere of 72° F. and 50 percent RH, then sawed and planed S4S to 3-5/8 by 3-5/8 inches, and finally center-ripped and thickness-planed on the sawn side into paired S4S 2 by 4's.

(3) Green cores center-ripped, brought to EMC at 72° F. and 50 percent RH (fig. 8), fully jointed on the flat side, thicknessed to 1-5/8 inches on a planer, and finally straight-line ripped, jointed, and planed to 3-5/8-inch width.

(4) Same as *3*, but studs grooved on the two edges to receive a pair of 8-foot, straight, glued-in-place Douglas-fir inserts at EMC in a 50-percent atmosphere.

(5) Green cores center-ripped, brought to EMC in an atmosphere of 72° F. and 50 percent RH, crosscut at midlength, fully jointed on the flat face, thicknessed, and ripped oversize. Resulting pieces end-spliced to similar sections from different half-logs, to make 8-

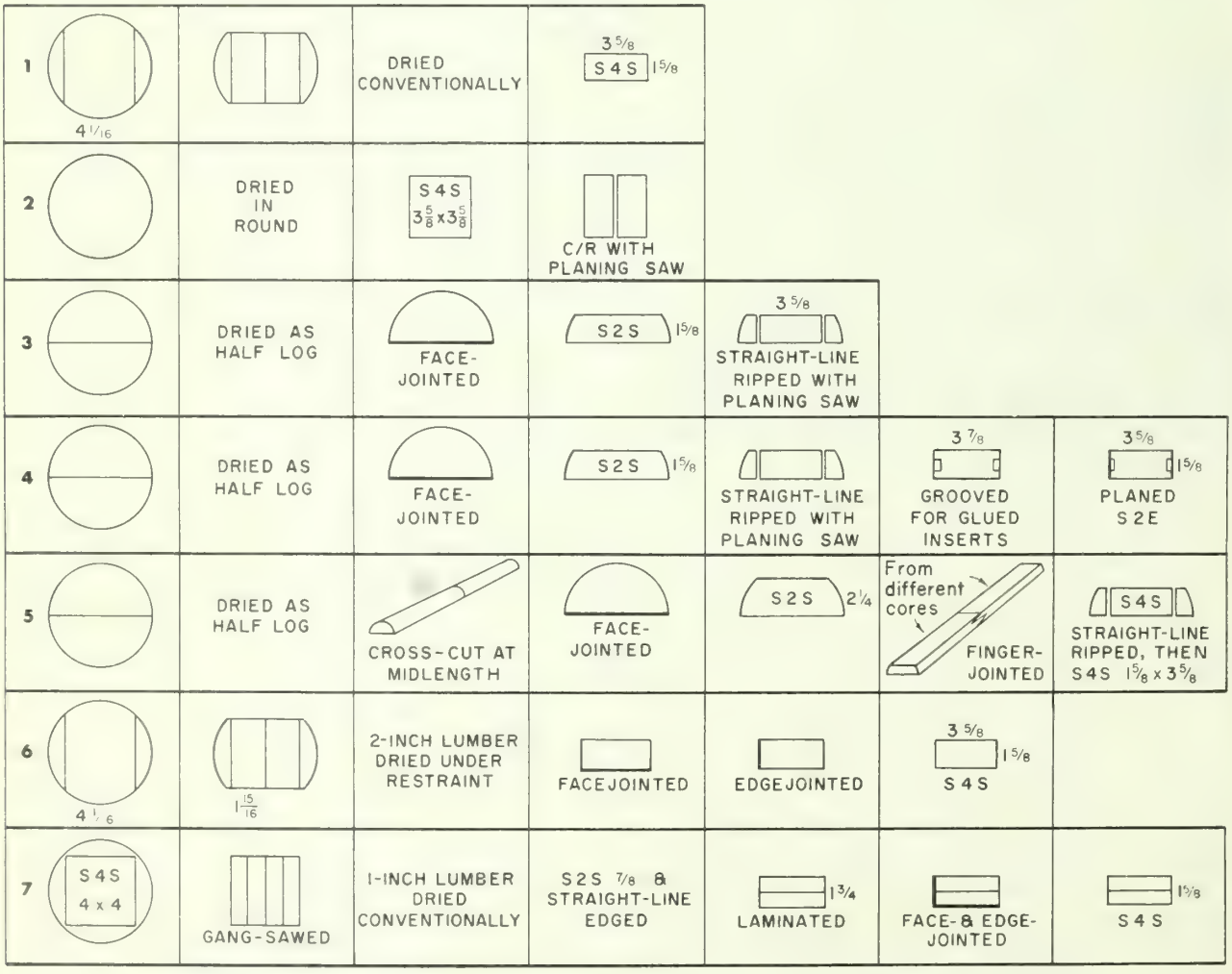

Figure 7.—Processes evaluated for converting veneer cores into 8-foot 2 by 4's.

foot pieces that were then jointed on one face and thickness planed to 1-5/8 inches, and finally jointed on one edge and planed on the other edge to 3-5/8 inches.

(6) Rough green 2 by 4's conventionally sawn from cores, dried under restraint on sticks to EMC at 50 percent RH, jointed on one side and one edge, and finally planed to thickness and width.

(7) Rough green 1 by 4's conventionally sawn from green cores, dried conventionally to EMC at 50 percent RH, surfaced two sides to 7/8-inch thickness, edged to maximum possible width with parallel sides, laminated in pairs to 8/4 thickness, jointed on one face and one edge, and finally planed to thickness and width.

Figure 8.—*Green veneer cores, either ripped or solid, were stacked for equilibration in an atmosphere held at 50 percent RH. The cores averaged 6 inches in diameter and were 8½ feet long.*

PROCEDURE

Primary Conversion and Drying

Forty-eight usable studs manufactured by each system were required. To ensure this number, a lot of 50 was made by each process.

The first lot was randomly selected from the S4S studs sawn on a skrag mill during the previous study. These studs had for several months been on sticks in the laboratory and were at EMC at 50 percent RH.

A group of 100 green southern pine cores, 8.7 feet long, was secured from Vancouver Plywood Company, Inc., Oakdale, Louisiana, in October 1965. On the day the cores were picked from the conveyor, the plant was having difficulty with the back-up rolls, so that the cores were somewhat spindle shaped, with the end diameter averaging 6.0 inches and the center diameter 6.4 inches. Weights averaged 102 pounds. Twenty-five of these cores were randomly assigned to each of lots 2, 3, 4, and 5.

Lots 3, 4, and 5 were center-ripped and, together with unripped cores of lot 2, stacked in the laboratory on sticks for 3½ months in an atmosphere controlled to approximately 72° F. dry-bulb temperature and 50 percent RH. During some periods RH dropped as low as 35 percent.

Fifty cores for lot 6 were picked out of the conveyor chain at Oakdale in December. Most were 5.3 inches in diameter, with some measuring 6 inches. They were immediately sawn to yield one rough green 2¼ by 4¼-inch oversize stud per core (cut as far off center as possible to simulate getting two 2 and 4's from each core). These were planed green S4S to a net size of 1-15/16 by 4-1/64 inches and stacked with a 2,000-pound top load on sticks bristling on both sides with small nails (fig. 9). The 4-foot-long sticks were placed every foot, i. e., 9 sticks per course. Thus restrained, the 2 by 4's were dried for 3½ months at 50 percent RH.

Figure 9.—*Tack-studded sticks used for drying green studs under restraint.*

Fifty cores for lot 7 were picked out of the Oakdale conveyor in January 1966 and sawed to yield 110 rough 1 by 4's sufficiently oversize to be planed green S4S to a net 1- by 4-inch dimension. These 1 by 4's were dried on sticks

in the laboratory at approximately 50 percent RH for a month, when they were surfaced S2S to 7/8-inch thickness and replaced on sticks and left until they attained EMC.

Secondary Conversion

For lot-1 studs, data on specific gravity and rings per inch were already at hand, as were values for MC, weight, and warp shortly after machining.

The 25 dry round cores in lot 2 were sawn into rough dry 4 by 4's on a small circular rig and then planed S4S to 3-5/8 by 3-5/8 inches with a heavy-duty planer and matcher. After they had been measured for warp, these squares were center-ripped (3/16-inch kerf) by feeding the straightest face against the guide fence of a circular saw. The rough face of each of the resulting two studs was removed by thicknessing to 1-5/8 inch.

At this stage the lot-2 studs were trimmed to 96 inches in length, weighed, and measured for warp. Crook (the curvature of the 1-5/8-inch edge) and bow (the curvature of the 3-5/8-inch face) were measured by placing each stud on a flat-ground gage table and reading the maximum distortion with wedges calibrated in hundredths of an inch. Twist was determined by holding three corners of the stud in contact with the gage table and measuring the elevation, above the table, of the fourth corner. A 1-inch cross-sectional slice was removed from one of the pieces of trim (adjacent to the 96-inch stud length), weighed, ovendried, weighed again, and finally measured for ovendry volume. Growth rate was determined from the same specimen. Studs of lots 3, 4, 6, and 7 were similarly measured after all processing had been completed.

The 50 dry half-logs of lot 3 were measured for bow and twist (they averaged 0.61 inch bow and 0.41 twist) and were fully jointed on the flat face to an S1S face virtually free of bow. The rounded top portion of the half-log was then planed until the piece was 1⅝ inches thick. With a template, parallel lines spaced 4¼ inches apart were scribed the length of the half-log to yield (after careful ripping) a central piece measuring 1⅝ by 4¼ inches and having minimum wane. One edge was jointed to remove all crook possible. The other edge was planed on a single surfacer to yield a net dimension of 1⅝ by 3⅝ inches with minimum wane.

The half-logs of lot 4 were processed like those of lot 3, except that the stud blanks were planed oversize (1-5/8 by 3-7/8 inches). Then a pair of 8½-foot, straight-grained, clear, Douglas-fir strips were brought to EMC at 50 percent RH, given a 3-minute dip in a water repellent, and glued with phenol resorcinol glue into 7/16- by 5/8-inch grooves that had been milled into the edge of each oversized stud. One edge of each stud was then jointed crook-free, and the other was thickness planed to bring the piece to 1-5/8 by 3-5/8 inches.

The dry half-logs of lot 5 were first crosscut at midlength. The flat side was jointed to within 1/8 inch of true, and the bark side was planed to produce a piece 2¼ inches thick. The two edges were scribed and straight-line ripped to yield 4½-inch width. The piece was then jointed crook-free and planed on the other edge to a width of 4¼ inches. Fingerjoints were cut on one end of each 4-foot piece and a 100-inch blank (2¼ by 4¼ inches) was made by end-gluing two such pieces from different cores. The phenol resorcinol adhesive was cured with heated plantens while the blank was under end and face pressure. The fingerjoints were made by Engineered Wood, Inc., El Dorado, Arkansas.

Each blank was then jointed on one face and planed on the other face until 1-5/8 inches thick. Next, one edge was jointed crook-free and the other edge planed to achieve a width of 3-5/8 inches. Figure 10 illustrates the fingerjoint. Specific gravity, rings per inch, and ovendry weight of each stud were obtained as for lot 2, except that data from cross-sectional slices at both ends were averaged.

The 50 studs in lot 6 were unstacked from their restrained drying position, measured for warp, jointed twice on one face (two 1/16-inch cuts) to remove a portion of the bow, thicknessed against the jointed back to 1-11/16 inches, and resurfaced on the originally jointed side to 1-5/8 inches. One edge was then jointed twice (two 1/16-inch cuts) to remove part of the crook, the other edge was planed on a single surfacer to bring the width to 3-11/16 inches, and finally the original jointed edge was planed to reduce width to 3-5/8 inches.

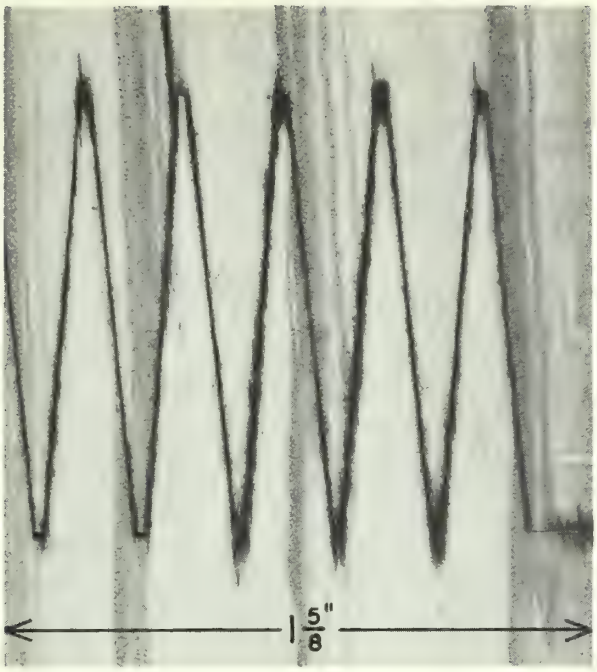

Figure 10.—*End splices were cut on a tenoner. Phenol resorcinol adhesive was cured between heated platens while the joint was under end and face pressure.*

Because of severe crook in the 110 dry 1 by 4's of lot 7, it was necessary to straight-line rip all boards to 2-7/8 inches wide (after first recording the maximum recoverable width in each board). By this expedient, 96 nearly wane-free 4/4 boards with parallel edges were obtained. With resorcinol adhesive applied with a roller at the rate of 65 pounds per 1,000 square feet of glueline (equally divided between mating surfaces), randomly paired boards were laminated. Bow was reduced in each laminate (1¾ inches thick) by taking a 1/16-inch jointing cut on one face and then planing the other face to yield 1-5/8-inch final dimension. Crook was reduced by jointing one edge and planing the other to a final width of 2-5/8 inches. Thus the crook in the 1 by 4's caused the studs to be 1 inch under the standard 3-5/8 inches.

Evaluation of Commercial Grade

An inspector of the Southern Pine Inspection Bureau graded each stud prior to the MC manipulation next described. He used the warp values recorded immediately after machining. After the MC manipulation, the same inspector regraded all studs on the basis of warp then present.

Evaluation of Stability at Various RH

Stability, as measured by amount of crook, bow, and twist caused by changes in RH, was evaluated for all seven lots of studs. Three groups of 16 sound studs were randomly drawn from each lot. One group from each lot was suspended in a humidity chamber at:

Relative humidity	Dry bulb temperature
Percent	°*F.*
87	76
52	70
35	79

The studs were suspended vertically from hooks at the center point of one end (fig. 11). After 4 weeks, each stud was remeasured for crook, bow, twist, and weight.

Absolute values for warp before and after conditioning, and changes in warp during conditioning, were compared by analysis of variance.

Figure 11.—
Studs were freely suspended from one end in rooms held at controlled humidities of 35, 52, and 87 percent.

RESULTS

Manufacturing Problems

The studs produced on the skrag mill were well stacked in the kiln and well dried. The crook-reducing planer was somewhat effective. Crook averaged 0.16 inch in rough dry studs and 0.11 inch after studs were machined. However, extremely warped studs could not be straightened by this manufacturing process (fig. 12).

Figure 12.—*Some studs made on a skrag mill had extreme warp when they emerged from the crook-reducing planer.*

The lot-2 cores that were dried whole developed substantial checks that persisted into the 4 by 4's subsequently produced. When the 4 by 4's were reduced to S4S 2 by 4's, the checks were still evident (fig. 13). They did not cause substantial degrade below SPIB Stud, however, because this grade will admit a 1¼-inch-deep check the full length or a through check 8 inches long. Crook in the S4S 4 by 4's was considerable, averaging 0.183 inch and ranging from 0.07 to 0.44. A straighter 4 by 4 could have been made by cutting an oversize cant and jointing two reference faces before thicknessing the cant to a net S4S 3-5/8 inches square. When the 4 by 4's were center-ripped into 2 by 4's, residual stresses considerably distorted the studs at the instant they were sawn free. Though the cores dried more than 4 months at 50 percent RH, it is doubtful that the pith and the exterior attained the same MC.

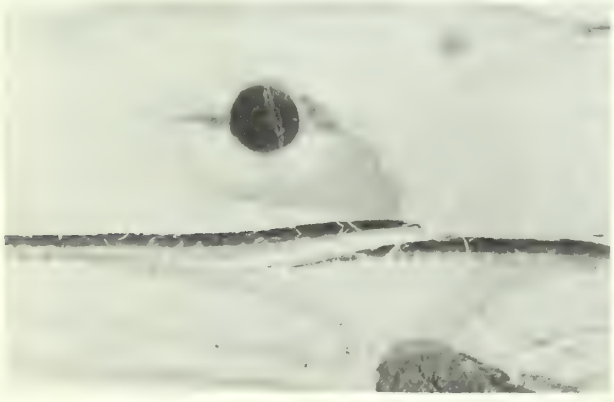

Figure 13.—*Checks that developed during drying of round cores persisted into the S4S 2 by 4's.*

Some half cores of lots 3 and 4 were severely distorted during drying (fig. 14). Removal of all warp by careful jointing and thicknessing achieved warp-free studs but with varying degrees of wane.

Figure 14.—*After drying, some half-cores had crook that caused wany edges on finished studs and bow that caused wane or taper on ends. Averages for dry half-cores were 0.61 inch of bow and 0.41 inch of twist.*

Crosscutting the lot-5 half-cores at midlength relieved the situation described above, and the resulting studs had less wane.

The lot-6 procedure—drying under restraint—may be worth another investigation. The nails in the sticks did not penetrate all studs uniformly, and therefore the top load caused built-in twist that degraded the studs considerably. Sticks covered with coarse abrasive cloth might have been more effective.

The lot-7 laminating procedure was impractical. The kerf and surfacing allowance prevented recovery of four 4/4 boards (to make a pair of 2 by 4's) from a 5.3-inch core; the drying distortion of the boards was so severe that the maximum dry recoverable width was only 2⅞ inches; and the 2-ply construction caused extreme bow when the MC was changed (fig. 15).

Figure 15.—Above: *Extreme drying crook necessitated edging 4/4 boards from a green width of 4 inches to a dry recoverable width of 2⅞ inches.* Below: *At high humidity, some studs laminated from these boards developed bow in excess of 3 inches.*

Statistics of Population

Only the cores for processes 2, 3, 4, and 5 belong to the same population. While cores for processes 1, 6, and 7 were randomly selected from the same plywood plant, they were picked on three widely separated days. This feature of the experimental design should be kept in mind while reading the tables of statistical analysis which treat all cores as a single population.

The skragged studs of lot 1 were more dense than the others (their average specific gravity, based on ovendry volume and weight, was 0.54, as compared to 0.52) and they had more rings per inch (6.0 compared to 3.5).

For all 336 studs, rings per inch accounted for 12 percent of the variation in specific gravity in a positive relationship (fig. 16).

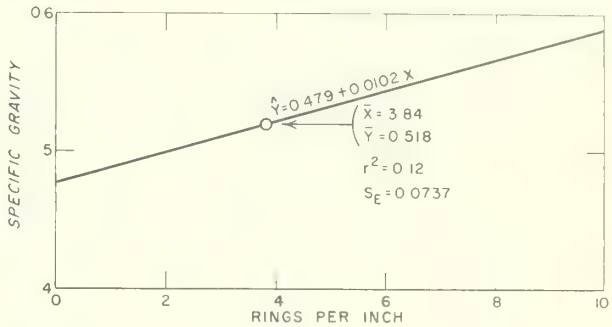

Figure 16.—*Growth rate (rings per inch) relative to specific gravity of the 336 studs. The relationship was significant at the 0.01 level.*

The 336 studs averaged 3.84 rings per inch, with distribution as follows:

Rings per inch	Number of studs	Percent of total
1	5	1.5
2	76	22.6
3	116	34.5
4	67	20.0
5	30	8.9
6	16	4.8
7	6	1.8
8	5	1.5
9	4	1.2
10	4	1.2
over 10	7	2.0
	336	100.0

Thus 197 studs, or 59 percent, had less than four rings per inch. They could at best qualify for SPIB Stud grade, and then only if their crook was less than 3/16 inch.

After 4 weeks of conditioning, twist was significantly related (negatively) to specific gravity (fig. 17). Crook and bow were related neither to specific gravity nor growth rate.

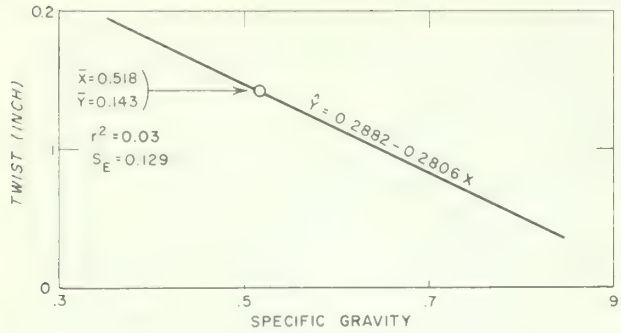

Figure 17.—*Specific gravity related to twist of studs after 4 weeks' exposure. This curve is defined by all 336 studs and all humidities. The relationship was significant at the 0.01 level. In stepwise analysis, growth rate (rings per inch) was not significant after specific gravity.*

Effectiveness of Processes

In the following discussion and tables, the numbered conversion processes are abbreviated as follows:

1	Skragged	5	Fingerjointed
2	Dried round	6	Restrained
3	Split	7	Laminated
4	Splined		

In all discussions of dollar value per thousand board feet of studs, the following F.O.B. mill prices (net after all discounts and commissions) are used:

SPIB Grade	Dollar value per M
1	99
2	93
Stud	83
3	37
Cutbacks to 7-foot Stud grade or better	75 (7/8 of $86)
4	37
Cut up	37

These prices were obtained by telephone conversation with knowledgeable producers during the high market of April 1966.

Crook immediately after machining was minimum in the fingerjointed and next to minimum in the splined, split, and laminated studs (table 4, column 2). Of the studs made by these four processes, 100 percent graded SPIB Stud or better immediately after machining. Skragged studs, while not crook-free, had a high dollar value because they had more rings per inch and hence—as seen in table 5, column 8—more of them qualified for grades 1 and 2. Studs from cores dried round and studs dried under restraint had low dollar value.

Table 4.—*Average crook, twist, bow, MC, dollar value, and grade of studs immediately after machining*

Process [1]	Crook	Twist	Bow	MC	Value/M [2]	SPIB Stud grade and better
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Inch	*Inch*	*Inch*	*Percent*	*Dollars*	*Percent*
Fingerjointed	0.050	0.078	0.070	11.0	85.71	100.0
Splined	.052	.104	.147	10.7	86.58	100.0
Split	.053	.062	.173	10.2	86.29	100.0
Laminated [3]	.062	.056	.074	10.4	87.71	100.0
Restrained	.074	.227	.184	10.2	[4] 73.00	68.8
Skragged	.119	.095	.169	11.2	[5] 86.12	87.5
Dried round	.156	.036	.254	11.0	72.67	72.9
Significance [6]	**	**	**	**	**	([7])

[1] Ranged by increasing crook.

[2] Value in dollars per 1,000 board feet F. O. B. mill after all discounts and commissions (as of April 1966).

[3] Although these laminated studs were only 2⅝ inches wide, they were graded as though they were the standard 3⅝-inch width.

[4] This low value caused by excessive twist.

[5] The skragged studs averaged 6.0 rings per inch compared to 3.5 rings for the other studs. They thus had more No. 1 and 2 grade, even though the total percent of SPIB Stud grade and better was only 87.5

[6] Analysis of variance by process at 0.01 level (**).

[7] Differences not statistically analyzed.

Table 5.—*Yield of each grade of stud according to process, before and after 4 weeks of conditioning* [1]

Grade	Fingerjointed		Split		Splined		Skragged		Laminated		Restrained		Dried round		All processes grouped	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Stud grade & better	100.0	89.6	100.0	87.5	100.0	83.3	87.5	81.2	100.0	70.8	68.7	62.5	72.9	54.2	89.9	75.6
SPIB 3 & worse	.0	10.4	.0	12.5	.0	16.7	12.5	18.8	.0	29.2	31.3	37.5	27.1	45.8	10.1	24.4
SPIB 1	6.2	6.2	12.5	10.4	14.6	14.6	33.3	6.2	12.5	8.3	20.8	20.8	4.1	4.2	14.9	10.1
SPIB 2	18.8	18.8	14.6	16.7	12.5	8.3	35.4	54.2	27.1	20.8	10.4	8.3	14.6	14.6	19.0	20.3
SPIB Stud	72.9	62.5	70.8	58.3	72.9	60.4	18.8	20.8	60.4	41.7	37.5	33.4	54.2	35.4	55.4	44.6
7-ft. cut backs [2]	2.1	2.1	2.1	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.6	.6
SPIB 3	.0	8.3	.0	8.3	.0	14.6	2.1	14.6	.0	16.7	29.2	35.4	22.9	29.1	7.7	18.1
SPIB 4	.0	2.1	.0	4.2	.0	2.1	8.3	.0	.0	12.5	.0	.0	2.1	14.6	1.5	5.1
Cut-up	.0	.0	.0	.0	.0	.0	2.1	4.2	.0	.0	2.1	2.1	2.1	2.1	.9	1.2

[1] Processes are ranged from left to right according to grade recovery (top two rows) after conditioning. Each process represented by 48 studs, i.e., humidity conditions were grouped.

[2] SPIB Stud grade and better only.

The laminated studs lost considerable value during the 4 weeks of conditioning, while those made by the other four contending processes (fingerjointed, skragged, split, and splined) retained high value (table 6, column 6).

Significant interactions between process and humidity (after 4 weeks of conditioning) are shown in tables 7 through 10. The fingerjointed studs had low crook, except at 87 percent RH (table 7), moderate twist (table 8), slight

Table 6.—*Warp and dollar value of studs after 4 weeks of conditioning* [1]

Factor	Crook	Twist	Bow	MC	Value/M	Specific gravity [2]	Growth rate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Inch	*Inch*	*Inch*	*Percent*	*Dollars* [3]		*R.p.i.*
Process [4]	**	**	**	**	**	N.S.	**
Splined	0.095	0.132	0.180	12.7	78.50	0.51	3.5
Fingerjointed	.114	.118	.174	13.3	80.92	.50	3.1
Restrained	.119	.248	.203	12.4	69.92	.52	4.1
Split	.140	.112	.253	12.6	80.42	.54	3.3
Laminated	.140	.145	.344	12.6	73.00	.52	3.6
Skragged	.162	.113	.269	[5] 8.2	80.79	.54	6.0
Dried round	.267	.131	.441	12.4	64.04	.51	3.3
Humidities [4]	**	N.S.	N.S.	**	N.S.	N.S.	N.S.
52 percent	.115	.130	.211	9.4	78.32	.51	3.9
87 percent	.115	.135	.255	18.6	75.70	.52	3.8
35 percent	.174	.163	.333	8.1	72.09	.52	3.9
Process × humidity	**	**	**	**	**	N.S.	N.S.

[1] Effect of primary variables and interactions tested for significance at 0.01 level (**). Averages include data on all studs; the only segregation is by the factors in column 1.

[2] Based on ovendry volume and weight.

[3] Value in dollars per 1,000 board feet F.O.B. mill after discount and commissions (as of April 1966).

[4] Ranged by increasing crook. Significant effects indicated by **.

[5] For reasons not clear, this value is unusually low.

bow except at 87 percent RH (table 9), and high dollar value (table 10).

Table 7.—*Crook after 4 weeks of conditioning* [1]

Process [2] (1)	RH 35 percent (2)	RH 52 percent (3)	RH 87 percent (4)
	Inch	*Inch*	*Inch*
Splined	[3] **0.087**	0.073	0.124
Fingerjointed	.100	**.058**	.185
Laminated	.118	.080	.224
Restrained	.159	.104	.094
Split	.160	.085	.174
Skragged	.253	.153	**.081**
Dried round	.343	.256	.203

[1] Interaction of process × humidity significant at 0.01 level.
[2] Ranged by increasing crook at 35 percent RH.
[3] Bold face accents process developing least crook at each humidity.

Table 8.—*Twist after 4 weeks of conditioning* [1]

Process [2] (1)	RH 35 percent (2)	RH 52 percent (3)	RH 87 percent (4)
	Inch	*Inch*	*Inch*
Dried round	[3] **0.104**	0.078	0.211
Laminated	.118	**.072**	.246
Split	.124	.105	.106
Fingerjointed	.140	.079	.135
Skragged	.148	.158	**.034**
Splined	.167	.124	.104
Restrained	.343	.292	.109

[1] Interaction of process × humidity significant at 0.01 level.
[2] Ranged by increasing twist at 35 percent RH.
Bold face accents process developing least twist at each humidity.

Table 9.—*Bow after 4 weeks of conditioning* [1]

Process [2] (1)	RH 35 percent (2)	RH 52 percent (3)	RH 87 percent (4)
	Inch	*Inch*	*Inch*
Fingerjointed	[3] **0.163**	**0.093**	0.266
Laminated	.215	.108	[4] .708
Splined	.220	.167	.153
Restrained	.261	.212	.135
Split	.316	.224	.218
Skragged	.445	.253	**.109**
Dried round	.709	.420	.195

[1] Interaction of process × humidity significant at 0.01 level.
[2] Ranged by increasing bow at 35 percent RH.
[3] Bold face accents process developing least bow at each humidity.
[4] Note extreme bow of laminated studs at high MC.

Table 10.—*Dollar value of studs after 4 week of conditioning* [1]

Process [2] (1)	RH 35 percent (2)	RH 52 percent (3)	RH 87 percent (4)
	Dollars/M [3]	*Dollars/M* [3]	*Dollars/M* [3]
Fingerjointed	[4] **84.88**	85.25	72.62
Laminated	79.12	**87.88**	52.00
Splined	74.50	83.38	77.62
Split	73.62	86.88	80.75
Skragged	68.50	84.12	**89.75**
Dried round	62.25	61.62	68.25
Restrained	61.75	59.12	88.88

[1] Interaction of process × humidity significant at 0.01 level.
[2] Ranged by decreasing dollar value at 35 percent RH.
[3] Value in dollars per 1,000 board feet F.O.B. mill after discounts and commissions (as of April 1966).
[4] Bold face accents process developing studs of maximum value at each humidity.

After conditioning, fingerjointed studs were within $4.79 of their original value (table 11, column 6), changes in warp were small (columns 2, 3, and 4), and only 10.4 percent of these studs graded SPIB 3 or worse (table 5, column 3). Splined studs did not have more average warp than the fingerjointed studs, but eight badly distorted pieces increased the proportion falling into grade 3 or below and caused considerable value loss.

Table 12 further reveals the superiority of the fingerjointed studs. It appears that these studs are most vulnerable to the 87 percent RH. Whereas they lost no value after 4 weeks' exposure in the 35- and 52-percent rooms, crook (table 7, column 4) caused them to drop $14.38 per M in the 87-percent room (table 12, column 5, value interaction).

The laminated studs, which were straight immediately after machining, suffered heavy degrade (—$34.88/M) in the 87-percent room. The degrade was caused by the 2-ply construction which is conducive to bow (figure 15 and column 5 of table 12).

The studs made from full-length split logs gave good results, but the fingerjointing process permits facejointing in 4-foot lengths and hence greater recovery with less wane from badly bowed, dry half-cores.

The splined studs were also of high value (tables 4 and 6, column 6), but the cost of obtaining and inserting stable splines makes the economics dubious—i.e., the studs probably were not sufficiently improved to warrant the additional expense.

Table 11.—*Change in warp and value of studs after 4 weeks of conditioning, as affected by process and humidity* [1]

Factor (1)	Crook (2)	Twist (3)	Bow (4)	MC (5)	Value/M (6)
	Inch	*Inch*	*Inch*	*Percent*	*Dollars* [2]
Process [3]	**	**	**	N.S.	N.S.
Splined	[4] **0.052**	0.056	0.093	4.3	−8.08
Restrained	.057	.094	**.091**	3.5	−3.08
Fingerjointed	.067	**.052**	.110	4.2	−4.79
Skragged	.084	.075	.138	4.0	−5.33
Split	.086	.055	.123	3.8	−5.88
Dried round	.136	.100	.251	4.0	−8.62
Humidities [3]	**	**	**	**	N.S.
52 percent	[4] **.044**	**.034**	**.078**	1.2	−3.93
35 percent	.096	.078	.183	2.7	−10.27
87 percent	.104	.113	.202	8.0	−7.45
Process × humidity	N.S.	**	**	**	N.S.

[1] Effect of primary variables and interactions tested for significance at 0.01 level (**). Averages include data on all studs; the only segregation is by the factors in column 1. Changes in warp and MC were analyzed without regard to sign (i.e., direction of change). The analysis for value recognized sign.

[2] Change in value: dollars per 1,000 board feet.

[3] Ranged by increasing change in crook. Significant effects indicated by **.

[4] Bold face accents process and humidity developing least change in warp.

Table 12.—*Change in warp and value after 4 weeks of conditioning* [1]

Effect (1)	Process [2] (2)	RH 35 percent (3)	RH 52 percent (4)	RH 87 percent (5)
		Inch	*Inch*	*Inch*
Change in twist				
	Fingerjointed	[3] **0.062**	**0.018**	0.076
	Splined	.066	.028	.075
	Split	.067	.033	**.065**
	Laminated	.069	.020	.191
	Skragged	.076	.060	.088
	Dried round	.083	.045	.171
	Restrained	.124	.036	.121
Change in bow		*Inch*	*Inch*	*Inch*
	Fingerjointed	**.098**	**.035**	.197
	Splined	.104	.039	.136
	Restrained	.121	.071	.081
	Split	.142	.061	.167
	Laminated	.156	.036	.636
	Skragged	.264	.087	**.061**
	Dried round	.397	.217	.139
Change in value per M		*Dollars*	*Dollars*	*Dollars*
	Fingerjointed	**0**	**0**	−14.38
	Laminated	−9.25	0	−34.88
	Split	−11.50	0	−6.12
	Splined	−11.50	−2.88	−9.88
	Dried round	−12.12	−11.50	−2.25
	Skragged	−12.50	−7.38	+3.88
	Restrained	−15.00	−5.75	**+11.50**

[1] Interactions significant at 0.01 level. Changes in warp were analyzed without regard to sign. The analysis for value recognized sign.

[2] Ranged by values at 35 percent RH.

[3] Bold face accents process and humidity combination producing best effect.

DISCUSSION AND CONCLUSIONS

Fingerjointing, splining, splitting, and skragging yielded studs that were comparable in value and fell within acceptable limits of degrade during conditioning subsequent to machining.

Because the skragged studs had more rings per inch than the others, more of them qualified for SPIB No. 1 and No. 2 grades. They thus showed high values even though they warped more than the others. In further study of this effect, an analysis was made of skragged studs whose ring counts were comparable to those of the other studs. The results indicated that 16 percent would have been grade 3 or worse, and that the value would have averaged $80 per M at time of machining. This is substantially below the average of $86 for fingerjointing, splining, and splitting. Of these last-named processes, fingerjointing appears to produce straight studs that have high value immediately after manufacture and also after exposure to changes in RH. Though complex, the fingerjointing process probably also achieves maximum recovery of material for a given degree of stud straightness.

POST-MACHINING TREATMENTS TO CONTROL CROOK AND MOISTURE CONTENT

A third phase of the research evaluated effectiveness in minimizing crook of seven post-machining dip or brush-on treatments applied to dry S4S studs cut from veneer cores.[1] In further analyses, crook was related to change in MC and to wood density. Cost of treatments was also determined.

METHODS

Two hundred and forty 8-foot 2 by 4's were randomly selected (except that those with crook in excess of ½-inch were rejected to reduce between-stud variance) from the 461 studs of the initial study. These cores had been kiln-dried, planed on an S4S planer equipped with crook reducer, and stored for several months on sticks in an atmosphere of approximately 50 percent RH. They displayed varying degrees of crook.

After the studs had been jointed as straight as possible on both edges, they were randomly divided into eight groups of 30 studs each and identified as A-1 . . . A-30 and so on to H-1 . . . H-30.

A. Control—no treatment.
B. 10-second dip in PAR,[2] a clear, glossless, nonfungicidal, penetrating, water-repellent finish.
C. 10-second dip in Woodlife,[2] a clear, penetrating, water-repellent preservative.
D. 10-second dip in Lumbrella[2] (9:1 ratio of water to concentrate).
E. 10-second dip in Convoy[2] (6:1 ratio of water to concentrate).
F. 10-second dip in experimental Millbrite[2] (9:1 ratio of water to concentrate).
G. Two brush coats of shellac (including ends of studs).
H. Two brush coats of finely divided aluminum (including ends of studs).

The dilutions in treatments D, E, and F are the manufacturer's recommendation. These three treatments are generically described as unpigmented, emulsified, semipenetrating, fungicidal water repellents in aqueous solution. They are designed for short-term inhibition of moisture change and fungus attack.

The coating of treatment H is described as: aluminum pigment powder for paint Fed. Spec. TTA468, Type II, Class B; mixed with varnish (for mixing with aluminum paint) Fed. Spec. TTV-81D, Type I.

Prior to treatment, a 1-inch cross-sectional slice was sawn from the end of each stud (to leave the stud 94 inches long). The slice was weighed, ovendried, weighed again, and the MC calculated. From these data the ovendry weight of each stud was determined.

Specific gravity and growth rate (rings per inch) were available from the initial study.

While still in the atmosphere controlled at 50 percent RH, each 94-inch stud was weighed before treatment, immediately after dipping

[1] The author appreciatively acknowledges the cooperation of W. H. Hopkins of Louisiana State University in Baton Rouge; Chapman Chemical Co., Memphis, Tennessee; Wood Treating Chemical Co., St. Louis, Missouri; and Protection Products Division of United States Plywood Corp., Kalamazoo, Michigan.

[2] These proprietary products are mentioned for information only; other water-repellent preparations are commercially available.

(or after each brush coat), and 36 to 60 hours after treatment.

Each group of 30 treated studs was randomly divided into three subgroups of 10 studs each. The studs were freely suspended by a hook centered in one end (fig. 18) in atmospheres controlled as follows:

Stud	Dry-bulb temp.	Wet-bulb temp.	Relative humidity
Numbers	*° F.*	*° F.*	*Percent*
11-20	80.7	64.7	42
21-30	80.1	77.6	90
1-10	Exterior exposure under continuous water spray		

Each stud was weighed on every 2-week anniversary of initial exposure until 8 weeks had elapsed, at which time crook was remeasured. At initial exposure both edges of each stud were essentially crook-free (actual crook was recorded on each edge), so that all studs developed increased crook in the three exposure situations. Only the change in crook, i.e., the increase, was recorded.

Control over the two humidity rooms was less than perfect. Actual RH ranged from 38 to 45 percent in the 42-percent room, and from 88 to 91 in the 90-percent room.

At the conclusion of the experiment, the full-length studs were weighed after drying for 7 days on sticks in a cross-circulating kiln held at 212° F. This procedure yielded an average stud MC of 1.8 percent (standard deviation = 1.2 percent).

Changes in crook from the initial condition at 50 percent RH, i.e., the increases in crook, were recorded immediately after the studs were thus dried.

EFFECTIVENESS OF TREATMENTS

As shown by the averages in table 13, studs in the 42-percent atmosphere crooked least (0.025 inch), while those in the 90-percent atmosphere were intermediate (0.106 inch). The continuous water shower caused most crook in all treatments (average of 0.208 inch). These amounts are significantly different at

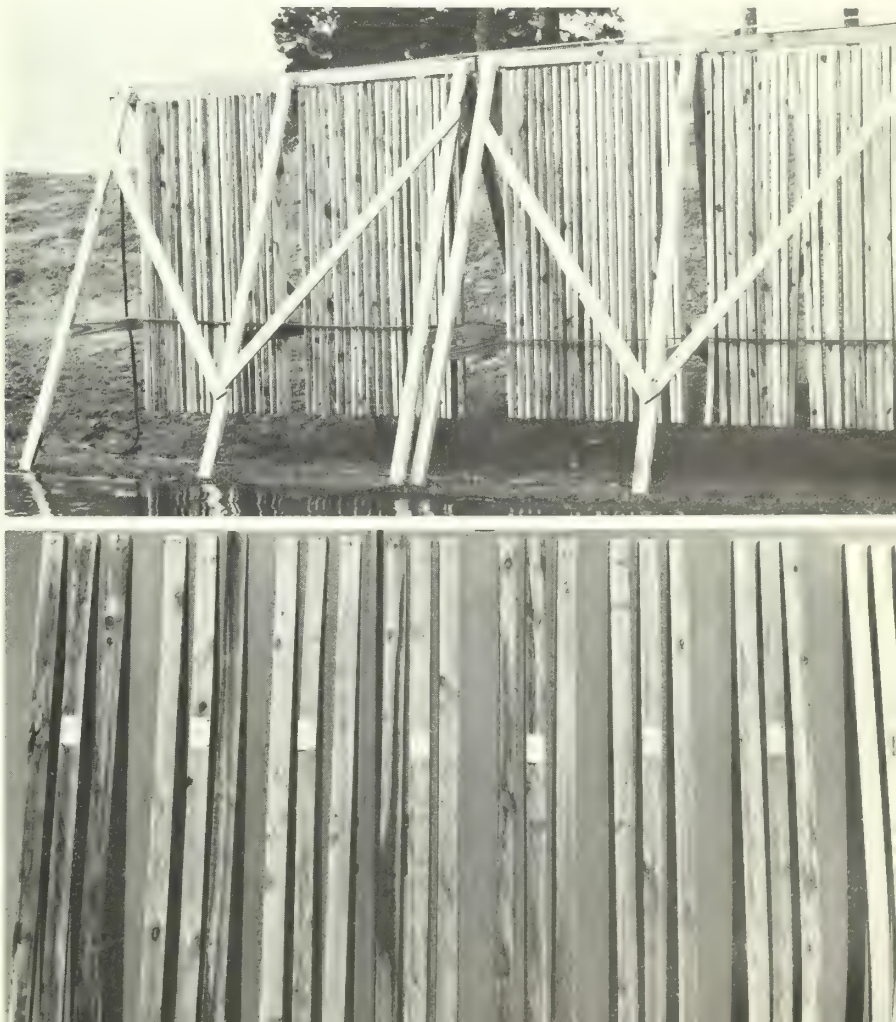

Figure 18.—
Above: *Studs freely suspended from one end under continuous water spray. Other 2 by 4's were similarly suspended in rooms held at 90 percent and 42 percent RH.* Below: *Typical studs after 8 weeks under the continuous shower: A, control; B, PAR; C, Woodlife; D, Lumbrella 9:1; E, Convoy 6:1; F, experimental Millbrite 9:1; G, two coats of shellac; H, two coats of aluminum paint.*

the 0.01 level. When all 240 studs were ovendried, the average increase in crook was 0.134 inch. Increase in crook for each treatment at each exposure condition is also shown in table 13.

Table 14 lists the increase in crook of all studs in the experiment by exposure condition and treatment. Boldface type indicates crook values that exceed the limitation of the SPIB Stud grade.

Table 13.—*Average increase in crook of studs after 8 weeks of exposure* [1]

Treatment	Exposure condition			After then ovendrying [2]
	42 percent RH	90 percent RH	Continuous water spray	
(1)	(2)	(3)	(4)	(5)
	Inch	*Inch*	*Inch*	*Inch*
Control	0.023	0.151	0.161	0.139
PAR	.019	.132	.252	.132
Woodlife	.025	.134	.271	.136
Lumbrella (9:1)	.030	.094	.293	.153
Convoy (6:1)	.031	.067	.190	.158
Experimental Millbrite (9:1)	.033	.064	.218	.113
Shellac	.022	.065	.167	.097
Aluminum paint	.017	.137	.116	.141
Average	.025	.106	.208	.134

[1] Initially, studs were essentially crook-free when at 9 percent EMC in an atmosphere held at approximately 50 percent RH. Each value in columns 2, 3, and 4 is the average for 10 studs.

[2] Each value is the average measured increase in crook (from crook-free at 9 percent EMC) in the 30 studs of each treatment category that had been previously subjected to the conditions indicated in columns 2, 3, and 4.

The tabulation below shows the average increase in crook—from crook-free at 9 percent EMC—for the 30 studs in each treatment. All three exposure conditions are grouped. The apparent differences between averages are not significant, nor do they approach significance. Also shown is the percent, by treatment, of 2 by 4's that exceeded the 3/16-inch maximum crook permitted by SPIB Stud grade. One stud exposed under the water shower developed a crook of 1.22 inches.

Treatment	Average increase in crook	Studs exceeding 3/16-inch crook
	Inch	*Percent*
Shellac	0.085	6.7
Aluminum	.090	20.0
Convoy	.096	16.7
Experimental Millbrite	.105	20.0
Control (untreated)	.112	16.7
PAR	.134	30.0
Lumbrella	.139	13.3
Woodlife	.143	26.7
	Average	18.8

No studs in any treatment exceeded 3/16-inch change in crook when in the 42-percent room at 9 percent MC (columns 1, 4, 7, 10, 13, 16, 19, and 22 of table 14). Of the eighty 2 by 4's in the 90-percent room at 13 percent MC, 13 studs or 16.2 percent exceeded the allowable 3/16-inch. Of the 80 studs at 22 percent MC (after 8 weeks under the water shower), 32 2 by 4's or 40 percent showed an increase in crook of 3/16-inch or more.

Forty-five (18.8 percent) of the 240 studs exceeded 3/16-inch crook. Of the 160 not exposed to water spray, 13 or 8.1 percent exceeded 3/16-inch increase in crook; all 13 were from the 90-percent room.

When all 240 studs were near ovendry, 56 of them or 23.3 percent exceeded 3/16-inch increase in crook from the initial crook-free condition at 9 percent EMC.

Analysis of variance in these data clearly showed that there were:

1. No significant differences between treatments (including control) in ability to suppress crook.

Table 14.—*Increase of crook in studs from each treatment and humidity condition ranged by magnitude of crook*[1 2 3]

Group A, control		Group B, PAR		Group C, Woodlife		Group D, Lumbrella		Group E, Convoy		Group F, Millbrite		Group G, shellac		Group H, aluminum	
42% RH	90% RH	42% RH	90% RH	42% RH	90% RH	42% RH	90% RH	42% RH	90% RH	42% RH	90% RH	42% RH	90% RH	42% RH	90% RH
(1)	(2)	(4)	(5)	(7)	(8)	(10)	(11)	(13)	(14)	(16)	(17)	(19)	(20)	(22)	(23)
Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0.05	**0.52**	0.03	**0.31**	0.04	**0.22**	0.08	**0.26**	0.09	**0.22**	0.06	**0.21**	0.05	0.18	0.03	**0.51**
.05	.25	.03	.28	.03	.12	.05	.15	.05	.18	.06	.17	.03	.11	.03	.34
.04	.18	.03	.20	.03	.18	.04	.14	.04	.07	.05	.08	.03	.08	.02	.20
.02	.13	.03	.18	.03	.14	.03	.10	.03	.04	.04	.06	.02	.08	.02	.10
.02	.13	.02	.14	.03	.14	.02	.08	.03	.04	.02	.04	.02	.07	.02	.08
.01	.12	.02	.10	.03	.13	.02	.07	.03	.03	.02	.02	.02	.06	.01	.05
.01	.09	.01	.03	.02	.12	.02	.06	.02	.03	.02	.02	.02	.03	.01	.03
.01	.04	.01	.03	.02	.09	.02	.04	.01	.02	.02	.02	.01	.02	.01	.02
.01	.03	.01	.03	.01	.09	.01	.03	.01	**.02**	.02	.01	.01	.02	.01	.02
.01	.02	.00	.02	.01	.02	.01	.01	.00	.02	.02	.01	.01	.00	.01	.02

Group B, PAR		Group C, Woodlife		Group D, Lumbrella		Group E, Convoy		Group F, Millbrite		Group G, shellac		Group H, aluminum	
Water spray		Water spray		Water spray		Water spray		Water spray		Water spray		Water spray	
(3)		(6)		(9)		(12)		(15)		(18)		(21)	(24)
Inch		*Inch*		*Inch*		*Inch*		*Inch*		*Inch*		*Inch*	*Inch*
0.52		**0.52**		**0.85**		**1.22**		**0.62**		**0.57**		**0.52**	**0.30**
.29		.32		.38		.67		.26		.37		.20	.24
.25		.32		.38		.33		.21		.30		.18	.20
.13		.33		.33		.18		.19		.28		.17	.13
.11		.31		.20		.17		.17		.23		.16	.10
.08		.23		.19		.09		.14		.14		.15	.06
.08		.18		.09		.09		.11		.11		.10	.04
.06		.15		.10		.08		.07		.10		.10	.04
.04		.11		.07		.07		.04		.04		.06	.03
.03		.05		.07		.03		.04		.04		.03	.02

[1] Each value is the increase in crook in one stud from an initial essentially crook-free condition at approximately 9 percent EMC in an atmosphere held at 50 percent RH.

[2] From each treatment category of 30 studs, 10 were subjected to 8 weeks at 42 percent RH and 10 at 90 percent RH, and 10 were hung outside under a continuous water spray.

[3] All values in bold face exceed permissible crook for SPIB Stud grade.

2. No significant interactions between treatment and exposure condition with respect to the suppression of crook.

It must therefore be concluded that all treatments were equally ineffective.

Moisture Content Control

All treatments considered, the following average MC's were observed in the three groups of 80 studs after 8 weeks' exposure (beginning from an EMC of 9 percent):

under continuous water shower	22 percent
at 90 percent RH	13 percent
at 42 percent RH	9 percent
at nearly ovendry	2 percent

Table 15 records the effect of treatment, humidity, and treatment × humidity interaction on average change in MC of the studs. Three observations can be made from this table:

1. While none of the treatments controlled crook, some appeared more effective than others in limiting the change in MC. The aluminum paint seemed most effective, all humidity conditions considered.
2. All humidity and treatment conditions considered, the most rapid change in MC occurred during the first 2 weeks (4.8 percent compared to an average of 2.0 percent for each of the following 2-week periods). Figure 19 illustrates this clearly for studs hung in the 90-percent room.
3. All factors and all interactions proved significant at the 0.01 level.

Figure 19 reveals the nature of the interactions. Two brush coats of aluminum paint appeared to be the most effective inhibitor of change in MC when the studs were subjected to a water shower. At 90 percent RH, the most effective treatment appeared to be aluminum paint, followed by shellac. The atmosphere at 42 percent RH did not differ enough from the beginning EMC conditions to provide a meaningful test.

It is pertinent to observe from columns 23 and 24 of table 14 that aluminum paint was ineffective in preventing crook in either the 90-percent atmosphere or under the water shower.

Table 15.—*Effect of primary variables on change in MC of studs* [1]

Factor	Change in percent MC
Treatment	**
Aluminum paint	1.2
Woodlife	2.2
PAR	2.3
Convoy	2.6
Shellac	3.0
Lumbrella	3.1
Millbrite (experimental)	3.3
Control (no treatment)	4.0
Relative humidity	**
42 percent	.0
90 percent	1.5
Under-continuous water shower	6.6
Period (elapsed weeks from start)	**
0-2	4.8
2-4	1.5
4-6	2.6
6-8	2.0
Treatment × humidity	**
Treatment × period	**
Period × humidity	**
Period × treatment × humidity	**

[1] Change from 9 percent EMC at approximately 50 percent RH. Averages include data on all 240 studs; the only segregation is by the factors in column 1. Significance of factors and interactions was tested at the 0.01 level (**).

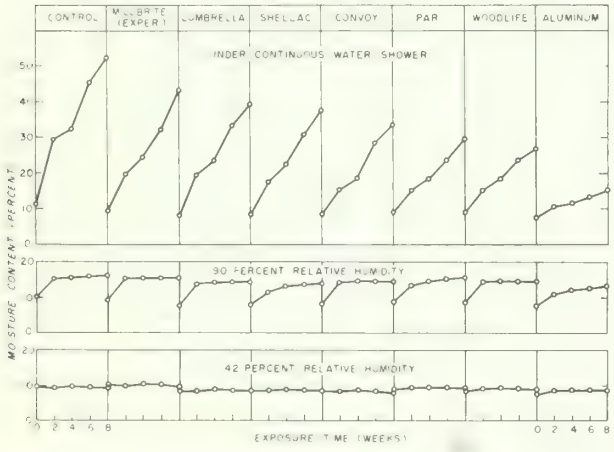

Figure 19.—*Interaction (significant at 0.01 level) of treatment, humidity condition, and exposure time with respect to MC of studs. All 240 were initially at EMC in an atmosphere controlled to approximately 50 percent RH. Each curve represents the average of 10 studs.*

Stain Control

Figures 18 and 20 show typical studs after exposure. No stain was evident after 8 weeks at either 42 or 90 percent RH. Studs from the 90-percent room were somewhat darker yellow than those from the 42-percent. None of the treatments except the aluminum paint contained pigmentation.

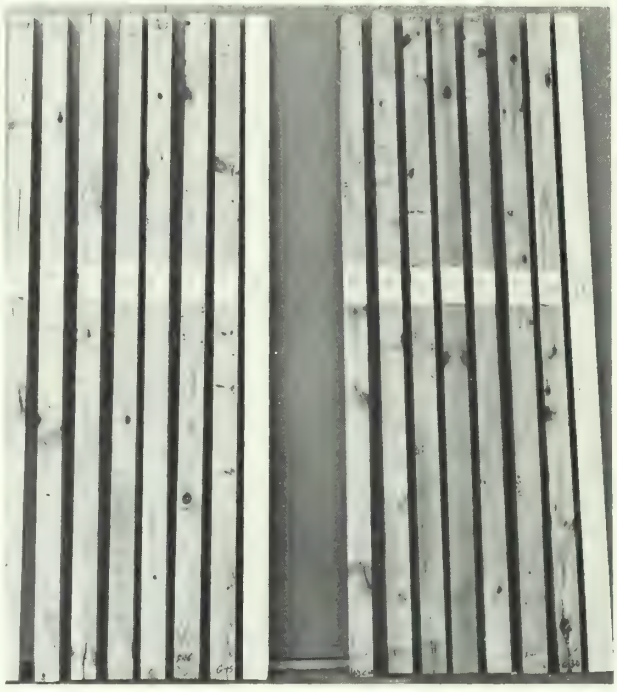

Figure 20.—*After 8 weeks of exposure at 42 percent RH no studs were discolored (left). Those from the 90-percent room (right) turned a somewhat darker yellow: A, control; B, PAR; C, Woodlife; D, Lumbrella 9:1; E, Convoy 6:1; F, experimental Millbrite 9:1; G, two coats of shellac; and H, two coats of aluminum paint.*

The studs were exposed to the continuous water spray at Alexandria, Louisiana, during March and April, and by the end of the 8 weeks they were considerably stained. On the basis of visual appearance, the antistain effectiveness of the treatments ranked as follows (best at top and poorest at bottom):

1. Aluminum paint
2. Woodlife
3. Experimental Millbrite, 9:1
4. PAR
5. Convoy, 6:1; Lumbrella, 9:1 (10-second dip); shellac (two brush coats)
6. Untreated conrtol

Cost of Treatments

Table 16 shows the weight of treating liquid picked up by each stud, and the amount of nonvolatile material remaining on each stud approximately 48 hours after treatment. The values in column 2 are from weighings made

Table 16.—*Average pickup of treating liquid and cost of material by treatment*

Treatment	Pickup of mixed liquids measured immediately after treatment	Pickup measured approximately 48 hours after treatment	Price per gallon of concentrate, in industrial quantities	Ratio of water to concentrate (by volume)	Material cost	
					Per stud treated	Per 1,000 board feet treated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pound per stud	*Pound per stud*	*Dollars*		*Dollar*	*Dollars*
Control	0.000	0.000	...	..	0.0000	0.00
Convoy 6:1	.120	.078	0.65	6:1	.0013	.24
Lumbrella 9:1	.120	.078	1.30	9:1	.0018	.34
Experimental Millbrite 9:1	.163	.041	1.35	9:1	.0027	.51
Woodlife	.156	.085	.90	0:1	.0206	3.86
Shellac						
1st coat	.053		..			...
2nd coat	.037	....	...			.
Total	.090	.088	2.12	0:1	.0251	4.71
PAR	.162	.085	2.00	0:1	.0477	8.94
Aluminum paint						
1st coat	.068	...	.	.		...
2nd coat	.063	...	...	. .	..	...
Total	.131	.116	3.00	0:1	.0483	9.06

immediately before and after application. The values in column 3 are less accurate because it was impossible to hold the working area at precisely 50 percent RH.

Table 16 also records the cost of the treating liquid, the cost of material per stud, and the cost of material per thousand board feet of studs treated. Treating costs ranged up to $9 per thousand board feet of studs.

CROOK AS RELATED TO MOISTURE CHANGES AND WOOD DENSITY

Crook Versus Moisture Content

Regression analysis revealed that change in MC up to fiber saturation point (assumed to be 28 percent) from the initial 9 percent EMC was significantly related to increase in crook (fig. 21). More simply stated, the greater the departure from crook-free MC (up to fiber saturation point), the greater the crook. When the average increase in crook of all 240 studs in the near ovendry condition was plotted, the point fell very close to the regression curve (fig. 21).

From the low coefficient of determination ($r^2 = 0.26$), however, it is evident that change in crook is not strictly proportional to change in MC. One must conclude that individual studs have very different and distinct longitudinal shrinkage characteristics (and hence propensity to crook) depending on pith location, amount of juvenile wood, amount and location of compression wood, specific gravity, and growth rate.

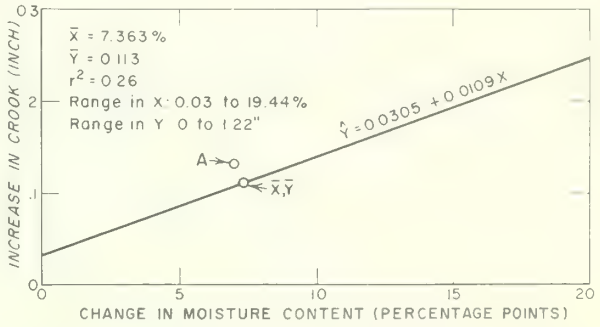

Figure 21.—*Increase in crook related to change in MC in the range up to fiber saturation point (28 percent). Studs were essentially crook-free at EMC in an atmosphere controlled at 50 percent RH. Curve is defined by all 240 treated studs, i.e., 80 under water shower, 80 in 90-percent room, and 80 in room held at 42 percent RH. The relationship was significant at the 0.01 level.*

Point A plots the average increase in crook and average change in MC of all 240 studs that were subsequently dried to an average of 1.76 percent MC (with standard deviation of 1.16 percent). Data for point A were not included in defining the regression line.

Although absolute prevention of MC change probably prevents change in crook, it is apparent that even a modest change in MC causes variable amounts of crook in individual studs.

Figure 22 illustrates that change in MC is inversely related to specific gravity and to rings per inch.

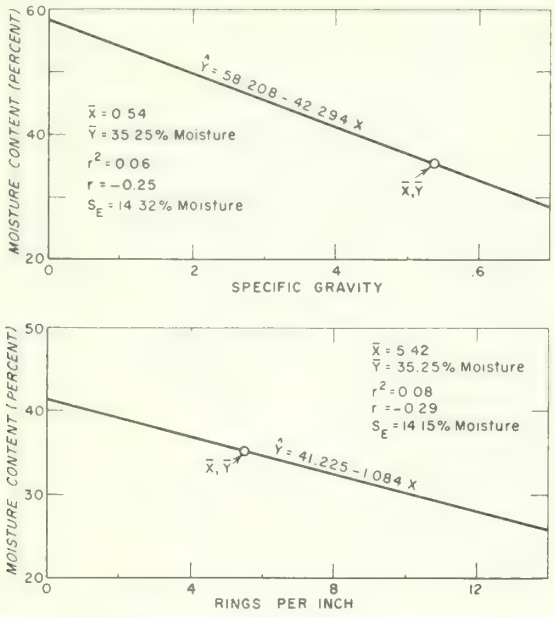

Figure 22.—*Effect of specific gravity (ovendry volume and weight) and rings per inch on final MC of studs after 8 weeks' exposure to a continuous water shower (beginning from 9 percent EMC). Eighty studs—10 from each treatment—define these curves. In stepwise multiple regression analysis, rings per inch did not prove significant after specific gravity was considered, nor was specific gravity significant after growth rate was considered.*

Crook Versus Specific Gravity and Growth Rate

Rate of growth of the wood in the 240 studs is described by a tabulation of frequency distribution:

Growth rate	Studs in each class	
Rings per inch	*Number*	*Percent*
1	0	0.0
2	12	5.0
3	61	25.4
4	50	20.8
5	41	17.1
6	28	11.7
7	17	7.1
8	7	2.9
9	3	1.3
10	1	.4
11-15	13	5.4
16-24	7	2.9
25 and over	0	.0
TOTAL	240	100.0

The studs averaged 5.4 rings per inch, but 25.4 percent had 3 rings, and more than 50 percent had less than 5. Average specific gravity (ovendry volume and weight) averaged 0.54 and ranged from 0.37 (3 rings per inch) to 0.86 (5 rings per inch).

Regression analysis indicated a positive relationship in which rings per inch accounted for 34 percent of the variation in specific gravity (fig. 23). This curve and those shown in figures 24 and 25 were defined by all 240 studs, and the relationships were significant at the 0.01 level.

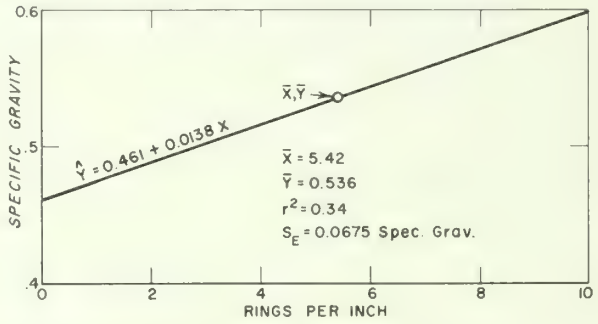

Figure 23.—*Growth rate (rings per inch) relative to specific gravity of studs.*

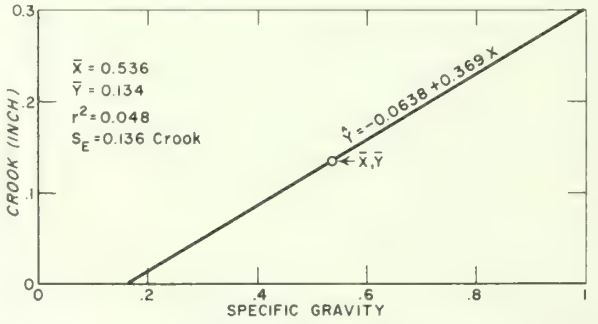

Figure 24.—*Specific gravity (ovendry volume and weight) relative to increase in crook from 9 percent EMC to nearly ovendry.*

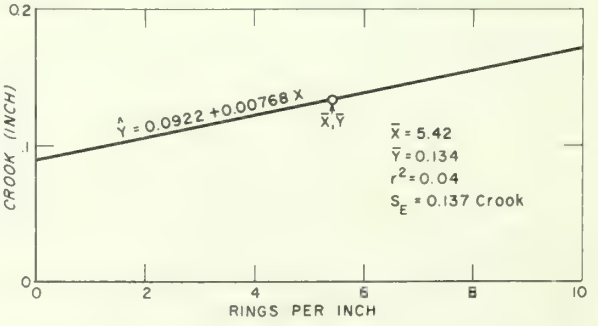

Figure 25.—*Growth rate (rings per inch) relative to increase in crook from 9 percent EMC to nearly ovendry.*

As previously described, in the final step of the experiment all studs were virtually ovendried to 1.8 percent MC. The increase in crook from this drying (crook-free at 9 percent EMC) showed a positive relationship to both specific gravity (fig. 24) and rings per inch (fig 25). Both relationships were weak, individually accounting for only 4 to 5 percent of the variation in crook.

When specific gravity and rings per inch were both considered in a stepwise regression analysis, rings per inch did not prove significant after specific gravity. Average increase in crook was 0.134 inch, and the range in the 240 studs was from 0 to 0.93 inch.

CONCLUSIONS

All treatments were equally ineffective in suppressing crook in studs sawn from southern pine veneer cores.

If studs similar to those in the study were manufactured crook-free when at 9 percent EMC and protected from free water, and then subjected to a very humid atmosphere (up to 90 percent RH), 16 percent could be expected to develop crook in excess of the 3/16-inch permitted by SPIB Stud grade. If similarly manufactured and subjected to a very dry atmosphere (down to 0 percent RH), 23 percent would exceed this limit in crook.

Two coats of either aluminum paint or shellac somewhat inhibited moisture change in 8-foot 2 by 4's under the test conditions.

Best control against visible stain in studs hung for 8 weeks under a continuous water spray was provided by: (1) aluminum paint, (2) Woodlife, (3) experimental Millbrite, and (4) PAR, in the order named.

Cost of materials (per thousand board feet of studs treated) for the different treatments varied from a low of $0.24 for one of the emulsified water repellents to $9.06 for two brush coats of aluminum paint.

Between the limits of fiber saturation and ovendry, departure from the MC at which each stud was crook-free accounted for 26 percent of the variation of the crook that later developed.

When studs were exposed to continuous wetting, rate of MC gain was inversely proportional to their specific gravity and rings per inch.

The 240 studs averaged 5.4 rings per inch, and rings per inch accounted for 34 percent of the variation in specific gravity in a positive relationship.

Studs with either high specific gravity or with many rings per inch crooked more than studs made from less dense and faster grown wood.

STRENGTH PROPERTIES

Modulus of elasticity in flatwise bending was determined nondestructively for studs from all seven manufacturing processes. Then the studs were destructively evaluated in edgewise bending, full-length tension, and full-length compression. Only 35 studs were evaluated in each test; results and conclusions should be interpreted with this in mind.

PROCEDURE

Fifteen studs of full 1⅝ by 3⅝-inch dimension were randomly selected from the studs previously manufactured by each of the seven processes (fig. 7)—a total of 105 studs. After the studs had been equilibrated to EMC at approximately 50-percent RH, the MOE in flatwise bending was determined by dead-weight loading at quarter points of an 80-inch span. One end of the stud rested on a plate supported on a knife-edge, the other end on a roller nest free to tip laterally and longitudinally. Ten-pound weights were placed at each load point until 100 pounds were in place—50 pounds at each load point. As each pair of weights was placed, deflections between supports were measured to the nearest 0.01 inch with a taut wire and scale. The wire was stretched between nails located at mid-depth of the 2 by 4 above supports, and the scale was at midlength of the beam. Deflection was read with a telescope. Width and height of each stud were measured in four places—at both support points and at the quarter points—and the values averaged.

Edgewise bending tests (fig. 26) were made on thirty-five 2 by 4's, i.e., five from each manufacturing process (fig. 27). Prior to test each stud was trimmed to 90-inch length. A 1-inch cross-sectional slice was taken from the inside end of the trimmed-off piece and MC determined. Specific gravity (ovendry weight and volume) was available from the second study. Midspan deflections were measured with a taut wire and scale. Readings to failure were taken at load intervals of 100 pounds to establish the deflection curve.

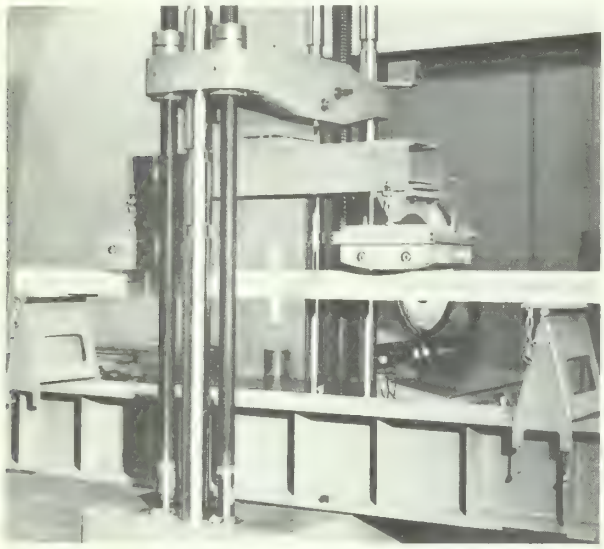

Figure 26.—*Setup of testing machine (120,000 pound capacity) for evaluating studs in edgewise bending over an 80 inch span with two-point loading. Load points were 40 inches apart at midspan. Rocker-type end supports were used, and roller nests were placed under one head to insure that loading was vertical. Rate of vertical movement of the loading heads was 0.137 inch per minute. The apparatus and speed of loading follow ASTM D 192-27, Static Tests of Timber.*

Full-length compression tests (fig. 28) were made on a second group of thirty-five 90-inch-long studs. Moisture contents were determined as before. Specific gravity values based on ovendry weight and volume were taken from the second study. Weights and volumes of the

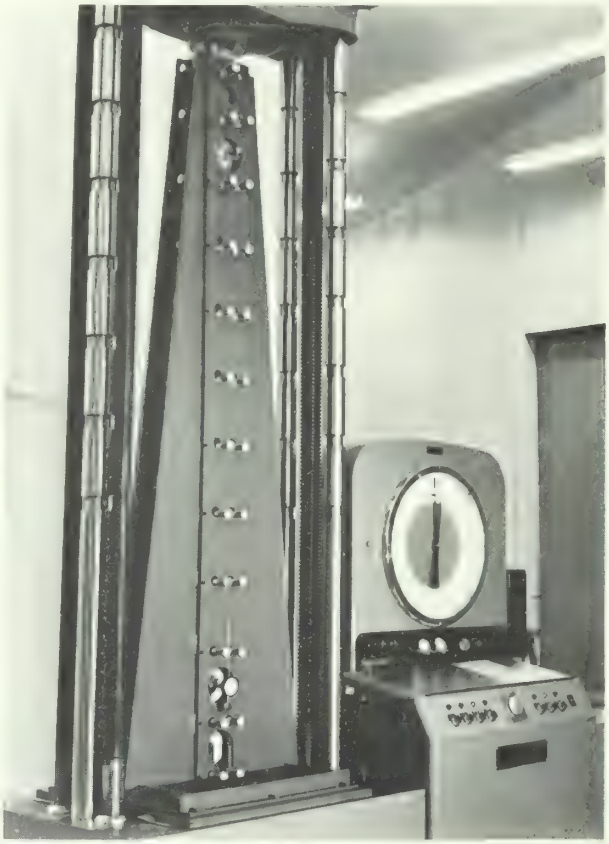

Figure 28.—*Testing machine arranged to evaluate 90 inch studs in full-length compression parallel to the grain. The specimen has lateral support in the flatwise as well as edgewise directions. Rate of vertical head travel was 0.063 inch per minute to yield a fiber strain rate of 0.0007 inch per inch per minute.*

Figure 27.—
Five representative studs from each of the seven manufacturing processes—from left: (1) dried in round, (2) skragged, (3) split, (4) splined, (5) fingerjointed, (6) restrained, and (7) laminated. These particular studs were broken in edgewise bending.

studs were also measured to permit calculation of specific gravity based on ovendry weight and volume at test. To measure deflection over a 64-inch gage length, two wires—one on each side of the stud—were connected to separate dial gage micrometers reading to 0.001 inch. Readings to failure were taken at 500-pound intervals of load.

The final group of thirty-five 2 by 4's was evaluated in full-length tension (fig. 29) by Bohannan's method.[3] Prior to test, studs were trimmed to 90 inches and evaluated for MC and specific gravity. Deflection was measured on one side only to the nearest 0.001 inch by arranging a wire and dial gage micrometer over a 60-inch gage length. Readings to failure were taken at 500-pound load intervals.

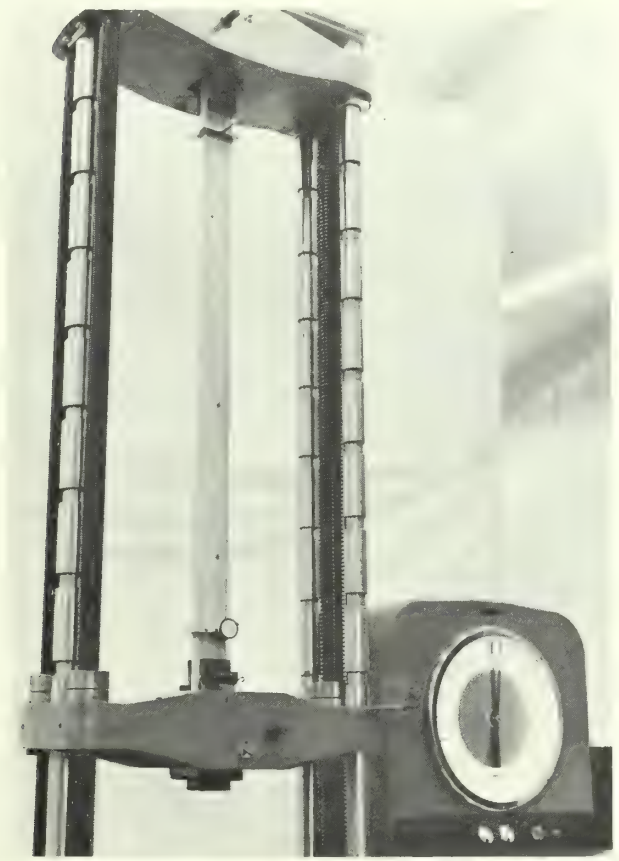

Figure 29.—*Testing machine arranged to evaluate 90 inch studs in full-length tension parallel to the grain. Distance between grips was approximately 70 inches, and gage length was 60 inches. Speed of loading head was 0.15 inch per minute.*

Calculation of Strength Values

For all studs loaded in edgewise bending, stress at proportional limit and modulus of rupture (MOR) were calculated from the standard flexure formula:

$$f = \frac{Mc}{I}$$

where f is the calculated stress, M is the applied moment, c is the distance from the neutral axis to the outer face of the beam, and I is the moment of inertia of the cross section. The MOE's in column 10 of table 17 were calculated from the deflection formula:

$$\Delta = \frac{Pa}{48EI}(3L^2 - 4a^2)$$

and the values in column 11 of table 17 and column 13 in tables 17, 18, and 19 were from the formula:

$$\Delta = \frac{Pa}{48EI}(3L^2 - 4a^2) + \frac{3Pa}{5GA}$$

where Δ is midspan deflection, inches

P = total load on beam, pounds

a = distance from support to load point, inches

E = MOE, p.s.i.

I = moment of inertia of cross section, inches^4

L = span length, inches

A = cross-sectional area, square inches

G = MOR or shear modulus, p.s.i.

The first of these equations is the usual one for midspan deflections of a simply supported beam under two equal concentrated loads symmetrically placed; deflection is assumed to be entirely due to bending stresses, and shear deflection is neglected. The second formula accounts for deflections caused by both bending and shear stresses. When MOE was calculated with the second formula, the shear modulus (G) was assumed to equal 1/16 the MOE.[4]

Strength values in full-length tension and compression were calculated from conventional formulae.

[3] Bohannan, Billy. Exploratory development of tension test method for structural-size lumber. U.S. Forest Serv. Res. Pap. FPL-40, 12 pp. Madison, Wisc. 1965.

[4] U.S. Forest Products Laboratory. Wood handbook (p. 78). U.S. Dep. Agr., Agr. Handbook 72, 528 pp., illus. 1955.

Table 17.—*Results of edgewise bending tests of 35 southern pine 2 by 4's*

Stud number	Width	Height	Rings per inch	MC	Specific gravity [1]	Maximum load	Stress at proportional limit	MOR [2]	MOE in edgewise bending		Deflection at maximum load	MOE in flatwise bending [3]	SPIB grade
									Uncorrected for shear	Corrected for shear			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	In.	*In.*		*Pct.*		*Lbs.*	*P. s. i.*	*P. s. i.*	*P. s. i.*	*P. s. i.*	*In.*	*P. s. i.*	
						SKRAGGED							
168	1.62	3.60	5	9.53	0.65	3,640	5,140	10,390	1,780,000	1,830,000	2.43	1,610,000	2
300	1.63	3.60	6	9.34	.50	3,120	6,250	8,860	1,940,000	2,000,000	1.93	1,670,000	2
385	1.62	3.62	5	10.13	.39	1,600	3,960	4,520	1,390,000	1,430,000	1.25	1,280,000	Stud
320	1.63	3.60	3	9.88	.48	1,330	3,120	3,760	1,670,000	1,720,000	.97	1,620,000	Stud
138	1.62	3.60	11	9.12	.56	2,810	6,860	8,030	2,000,000	2,050,000	1.83	1,930,000	2
Average	1.62	3.60	6.2	9.60	.52	2,500	5,070	7,110	1,760,000	1,810,000	1.68	1,620,000	
						DRIED ROUND							
13A	1.61	3.64	3	9.94	.44	2,020	3,660	5,670	1,400,000	1,440,000	1.65	1,290,000	Stud
2A	1.63	3.63	3	10.61	.39	1,150	2,800	3,200	940,000	970,000	1.23	1,060,000	3
16A	1.61	3.63	3	9.36	.52	1,460	3,400	4,130	1,210,000	1,250,000	1.53	1,270,000	Stud
12A	1.64	3.64	1	10.71	.45	910	2,210	2,510	840,000	860,000	1.47	890,000	Stud
19A	1.62	3.64	3	10.04	.44	1,500	4,190	4,190	1,380,000	1,420,000	1.13	1,220,000	Stud
Average	1.62	3.64	2.6	10.13	.45	1,410	3,250	3,940	1,150,000	1,190,000	1.40	1,150,000	
						SPLIT							
2A	1.62	3.63	4	9.66	.48	3,490	3,950	9,800	1,320,000	1,360,000	3.10	1,330,000	1
1	1.63	3.63	3	10.01	.47	2,060	4,480	5,760	1,100,000	1,100,000	2.06	1,250,000	Stud
18A	1.63	3.63	5	9.49	.63	1,950	4,480	5,430	1,200,000	1,240,000	1.76	1,130,000	2
7A	1.63	3.61	2	9.76	.42	1,840	4,530	5,200	1,180,000	1,210,000	1.73	1,130,000	Stud
10	1.62	3.63	1	9.85	.59	990	2,780	2,780	1,100,000	1,130,000	.91	1,100,000	Stud
Average	1.63	3.63	3.0	9.75	.52	2,070	4,040	5,790	1,180,000	1,210,000	1.91	1,190,000	
						SPLINED							
14A	1.60	3.58	2	9.85	.44	1,410	3,510	4,110	1,480,000	1,520,000	1.12	1,440,000	Stud
10A	1.61	3.58	3	10.04	.44	1,780	3,780	5,180	1,700,000	1,750,000	1.23	1,560,000	Stud
8	1.59	3.59	2	10.24	.51	1,780	2,340	5,210	910,000	940,000	3.02	750,000	Stud
3A	1.60	3.59	2	9.76	.41	1,030	3,000	3,000	1,120,000	1,150,000	.95	1,000,000	Stud
16A	1.57	3.59	2	9.95	.43	1,730	3,850	5,130	1,390,000	1,430,000	1.48	1,300,000	Stud
Average	1.59	3.59	2.2	9.97	.45	1,550	3,300	4,530	1,320,000	1,360,000	1.56	1,210,000	
						FINGERJOINTED							
28	1.59	3.58	4	10.57	.59	2,260	2,650	6,640	940,000	970,000	3.45	960,000	Stud
14	1.59	3.58	3	11.15	.46	1,620	2,360	4,770	710,000	730,000	3.07	750,000	Stud
48	1.59	3.57	3	9.94	.45	670	1,970	1,970	1,260,000	1,300,000	.53	1,280,000	Stud
6	1.59	3.56	3	10.74	.53	1,580	2,980	4,690	1,070,000	1,100,000	1.78	1,070,000	Stud
46	1.60	3.57	5	10.23	.63	1,980	2,350	5,820	920,000	950,000	2.93	880,000	1
Average	1.59	3.57	3.6	10.53	.53	1,620	2,460	4,780	980,000	1,010,000	2.35	990,000	
						RESTRAINED							
45	1.62	3.51	3	9.63	.48	920	2,770	2,770	1,610,000	1,650,000	.61	1,560,000	Stud
44	1.62	3.61	4	10.26	.47	1,370	3,690	3,890	1,400,000	1,440,000	.97	1,410,000	2
34	1.61	3.61	2	9.30	.53	1,470	4,210	4,210	780,000	800,000	2.05	740,000	Stud
41	1.62	3.61	2	10.90	.71	1,630	3,410	4,630	1,070,000	1,110,000	1.70	1,110,000	Stud
11	1.60	3.62	4	9.35	.51	1,350	2,840	3,860	1,360,000	1,400,000	1.08	1,420,000	2
Average	1.61	3.59	3.0	9.89	.54	1,350	3,380	3,870	1,240,000	1,280,000	1.28	1,250,000	
						LAMINATED							
48	1.62	2.65	7	11.38	.54	880	3,430	4,620	980,000	990,000	2.56	920,000	1
47	1.63	2.62	3	10.00	.57	780	3,630	5,150	1,270,000	1,280,000	1.78	1,220,000	Stud
3	1.62	2.63	8	10.22	.81	1,830	7,480	9,760	1,790,000	1,820,000	2.90	1,720,000	2
37	1.62	2.61	5	11.63	.51	900	4,370	4,890	1,170,000	1,190,000	2.15	1,160,000	2
20	1.62	2.64	4	9.94	.54	1,420	4,520	7,530	1,310,000	1,330,000	3.12	1,190,000	1
Average	1.62	2.63	5.4	10.63	.59	1,160	4,690	6,390	1,300,000	1,320,000	2.50	1,240,000	

[1] Based on O. D. volume and weight of 1-inch cross-sectional disc.
[2] All studs failed first on the tension side.
[3] Evaluated by nondestructive flatwise bending test. Values corrected for shear.

Table 18.—*Results of full-length tension tests of 35 southern pine 2 by 4's*

Stud number	Width	Height	Rings per inch	MC at test	Specific gravity: Ovendry wt. and vol. [1]	Specific gravity: Vol. at test MC and ovendry wt. [2]	Maximum load	Stress at proportional limit	Stress at maximum load	MOE	Deflection at maximum load [3]	MOE in flatwise bending [4]	SPIB grade
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	In.	*In.*		*Pct.*			*Lbs.*	*P.s.i.*	*P.s.i.*	*P.s.i.*	*In.*	*P.s.i.*	
						SKRAGGED							
270	1.62	3.61	5	8.78	0.50	0.51	17,050	2,220	2,920	1,530,000	0.111	1,650,000	2
180	1.62	3.61	4	8.56	.56	.43	11,350	1,880	1,940	1,160,000	.085	1,130,000	2
94	1.63	3.60	7	8.26	.51	.53	17,780	2,640	3,030	1,910,000	.095	1,890,000	2
334	1.63	3.62	3	8.93	.45	.47	18,580	2,800	3,150	1,530,000	.129	1,570,000	3
308	1.63	3.61	3	8.83	.46	.49	16,900	2,810	2,870	1,080,000	.144	1,160,000	2
Average	1.63	3.61	4.4	8.67	.50	.49	16,330	2,470	2,780	1,440,000	.113	1,480,000	
						DRIED ROUND							
21A	1.64	3.62	3	9.44	.48	.48	11,150	1,850	1,880	740,000	.129	870,000	Stud
15	1.64	3.63	4	8.64	.48	.44	12,830	2,100	2,160	1,160,000	.111	1,230,000	Stud
22A	1.62	3.64	3	9.45	.36	.53	15,700	2,290	2,660	600,000	.270	670,000	3
14	1.64	3.62	2	8.91	.38	.41	17,800	1,600	3,000	1,250,000	.137	1,260,000	4
10	1.64	3.64	4	9.16	.51	.48	24,630	4,100	4,130	1,850,000	.130	1,720,000	1
Average	1.64	3.63	3.2	9.12	.44	.47	16,420	2,390	2,770	1,120,000	.155	1,150,000	
						SPLIT							
18	1.61	3.61	4	8.83	.42	.46	24,800	1,720	4,270	1,590,000	.166	1,430,000	1
13A	1.63	3.62	5	9.31	.48	.48	14,230	2,370	2,410	1,660,000	.080	1,280,000	2
25	1.62	3.62	3	9.34	.46	.53	21,600	1,540	3,690	960,000	.251	800,000	Stud
3	1.62	3.62	3	9.32	.45	.47	28,630	2,730	4,890	1,840,000	.163	1,600,000	Stud
15A	1.60	3.62	3	9.00	.47	.47	13,230	2,250	2,280	1,200,000	.110	1,240,000	Stud
Average	1.62	3.62	3.6	9.16	.46	.48	20,490	2,120	3,500	1,450,000	.154	1,270,000	
						SPLINED							
17A	1.59	3.58	3	8.88	.49	.46	15,000	1,580	2,640	1,270,000	.136	1,310,000	Stud
19A	1.61	3.59	2	9.35	.45	.45	20,580	1,900	3,560	1,840,000	.114	1,690,000	Stud
16	1.60	3.59	2	9.47	.45	.47	15,800	1,480	2,750	1,460,000	.120	1,140,000	Stud
11	1.58	3.59	2	9.23	.45	.46	14,780	1,590	2,610	1,070,000	.145	1,250,000	Stud
13	1.60	3.58	2	9.42	.44	.45	9,850	1,660	1,720	1,130,000	.088	1,160,000	Stud
Average	1.60	3.59	2.2	9.27	.46	.46	15,200	1,640	2,660	1,350,000	.121	1,310,000	
						FINGERJOINTED							
20	1.60	3.57	3.5	9.35	.51	.50	17,050	1,490	2,990	1,040,000	.186	950,000	2
44	1.60	3.56	3.5	9.43	.48	.47	19,180	2,020	3,360	1,290,000	.170	1,290,000	2
2	1.59	3.57	2.0	8.88	.44	.43	11,680	2,030	2,060	1,320,000	.091	1,140,000	Stud
7	1.59	3.57	3.5	9.14	.48	.49	9,630	1,670	1,700	1,130,000	.083	1,050,000	Stud
11	1.59	3.57	2.0	8.68	.46	.44	8,130	1,430	1,430	970,000	.088	930,000	Stud
Average	1.59	3.57	2.9	9.10	.47	.47	13,130	1,730	2,310	1,150,000	.124	1,070,000	
						RESTRAINED							
28	1.63	3.58	2	9.14	.51	.51	7,750	940	1,330	1,180,000	.065	1,040,000	Stud
6	1.60	3.60	6	8.47	.59	.59	13,650	1,480	2,370	1,610,000	.103	1,620,000	Stud
15	1.62	3.60	8	9.58	.68	.64	35,900	1,630	6,160	2,220,000	.198	1,930,000	1
3	1.62	3.60	2	9.18	.50	.44	9,550	1,630	1,640	1,120,000	.082	1,230,000	3
43	1.59	3.58	4	9.10	.44	.50	20,630	3,600	3,630	970,000	.223	1,020,000	1
Average	1.61	3.59	4.4	9.09	.54	.54	17,500	2,180	3,030	1,420,000	.134	1,370,000	
						LAMINATED							
24	1.63	2.64	4	9.06	.55	.50	15,130	3,490	3,520	1,380,000	.146	1,290,000	Stud
41	1.62	2.64	4	9.74	.55	.61	19,800	1,990	4,630	1,100,000	.253	870,000	2
35	1.63	2.66	3	9.46	.50	.50	9,650	2,190	2,220	1,430,000	.087	1,300,000	Stud
45	1.62	2.64	4	9.79	.48	.46	7,950	1,750	1,860	1,220,000	.088	1,140,000	2
13	1.59	2.64	4	8.75	.48	.46	11,630	1,790	2,770	1,470,000	.108	1,320,000	2
Average	1.61	2.64	3.8	9.36	.51	.51	12,830	2,240	3,000	1,320,000	.136	1,180,000	

[1] Based on ovendry volume and weight of 1-inch cross-sectional slice.
[2] Based on volume of entire stud at test corrected to ovendry weight using MC in column 5.
[3] Elongation in gage length of 60 inches.
[4] Evaluation by nondestructive flatwise bending test. Values corrected for shear.

Table 19.—*Results of full-length compression tests of 35 southern pine 2 by 4's*

Stud number	Width	Height	Rings per inch	MC at test	Specific gravity: Ovendry wt. and vol. [1]	Specific gravity: Vol. at test MC and ovendry wt. [2]	Maximum load	Stress at proportional limit	Stress at maximum load	MOE	Deflection at maximum load [3]	MOE in flatwise bending [4]	SPIB grade
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	In.	*In.*		*Pct.*			*Lbs.*	*P.s.i.*	*P.s.i.*	*P.s.i.*	*In.*	*P.s.i.*	
						SKRAGGED							
254	1.62	3.61	3	8.85	0.45	0.46	34,900	4,270	5,970	1,600,000	0.280	1,700,000	2
119	1.62	3.61	6	8.23	.56	.53	33,800	3,400	6,760	1,160,000	.469	1,200,000	2
146	1.62	3.61	6	8.24	.50	.53	39,150	3,930	6,690	1,530,000	.347	1,560,000	2
241	1.63	3.61	3	8.77	.50	.50	35,400	3,740	6,020	1,490,000	.312	1,450,000	Stud
417	1.63	3.59	8	7.91	.56	.61	28,400	3,160	4,860	1,360,000	.313	1,320,000	Stud
Average	1.62	3.61	5.2	8.40	.51	.53	34,330	3,700	6,060	1,430,000	.344	1,450,000	
						DRIED ROUND							
12	1.64	3.63	1	9.96	.43	.45	23,600	2,020	3,970	740,000	.431	780,000	Stud
25A	1.63	3.63	3	9.51	.46	.43	24,080	2,370	4,070	930,000	.368	990,000	Stud
17	1.63	3.62	6	9.74	.54	.55	36,650	3,220	6,210	1,470,000	.421	1,530,000	1
23	1.63	3.63	2	9.22	.41	.43	20,800	2,550	3,540	970,000	.251	1,010,000	Stud
4	1.63	3.62	3	9.36	.57	.57	29,750	2,200	5,040	820,000	.690	870,000	3
Average	1.63	3.63	3.0	9.56	.48	.49	26,980	2,470	4,570	990,000	.432	1,040,000	
						SPLIT							
17	1.61	3.62	2	8.52	.50	.43	17,600	2,400	3,020	940,000	.212	960,000	Stud
16	1.63	3.61	2	9.47	.57	.53	29,100	2,720	4,950	990,000	.480	1,010,000	Stud
20	1.61	3.62	4	9.60	.64	.55	29,600	2,060	5,080	1,030,000	.540	1,110,000	2
17A	1.62	3.63	2	9.83	.44	.46	21,250	2,210	3,610	1,300,000	.192	1,250,000	Stud
3A	1.62	3.63	4	9.91	.47	.48	28,250	3,320	4,800	1,620,000	.284	1,740,000	2
Average	1.62	3.62	2.8	9.47	.52	.49	25,160	2,540	4,290	1,180,000	.342	1,210,000	
						SPLINED							
23	1.60	3.59	4	8.41	.47	.47	27,800	2,700	4,840	1,170,000	.471	1,110,000	Stud
18A	1.60	3.58	5	9.41	.55	.51	34,600	2,700	6,040	1,380,000	.468	1,370,000	1
17	1.60	3.57	2	8.90	.45	.46	24,930	2,360	4,370	1,100,000	.315	1,100,000	Stud
19	1.60	3.59	2	9.08	.46	.47	28,000	2,790	4,880	1,460,000	.237	1,470,000	Stud
22	1.61	3.58	10	9.15	.64	.68	41,400	3,990	7,190	1,830,000	.316	1,850,000	1
Average	1.60	3.58	4.2	8.99	.51	.52	31,350	2,910	5,460	1,390,000	.361	1,380,000	
						FINGERJOINTED							
25	1.60	3.57	2.5	9.54	.45	.45	28,350	2,450	4,970	1,360,000	.307	1,380,000	Stud
47	1.60	3.56	2.5	9.99	.45	.46	18,750	2,980	3,290	1,230,000	.171	1,210,000	Stud
13	1.59	3.57	3.0	8.77	.42	.48	22,900	2,200	4,030	810,000	.482	760,000	Stud
39	1.60	3.58	3.5	9.78	.52	.49	26,950	2,090	4,700	1,010,000	.482	1,010,000	2
36	1.61	3.57	3.0	9.71	.50	.45	24,080	2,600	4,190	1,130,000	.329	1,210,000	Stud
Average	1.60	3.57	2.9	9.56	.47	.47	24,210	2,460	4,240	1,110,000	.354	1,110,000	
						RESTRAINED							
10	1.62	3.60	3	8.30	.47	.48	31,000	2,570	5,320	1,060,000	.449	1,070,000	3
40	1.62	3.61	5	9.91	.48	.44	28,790	3,080	4,920	1,260,000	.280	1,200,000	1
42	1.61	3.60	5	9.21	.50	.48	29,810	2,330	5,140	1,460,000	.298	1,550,000	2
2	1.62	3.61	2	8.04	.60	.44	23,080	2,140	3,940	790,000	.425	890,000	Stud
48	1.61	3.58	3	8.56	.55	.58	25,580	1,910	4,440	680,000	.601	720,000	Stud
Average	1.61	3.60	3.6	8.80	.52	.48	27,490	2,410	4,750	1,050,000	.411	1,090,000	
						LAMINATED							
38	1.62	2.65	2	9.74	.43	.44	18,950	3,030	4,420	1,130,000	.279	1,160,000	Stud
7	1.63	2.63	7	8.92	.45	.47	19,850	3,260	4,620	1,470,000	.219	1,410,000	2
4	1.62	2.62	3	8.86	.51	.51	18,900	2,590	4,460	930,000	.440	1,010,000	Stud
43	1.63	2.64	2	8.09	.46	.48	18,150	1,860	4,220	900,000	.409	880,000	Stud
36	1.63	2.64	4	9.34	.57	.52	19,830	1,740	4,610	1,020,000	.436	920,000	Stud
Average	1.63	2.64	3.5	8.99	.48	.48	19,136	2,500	4,470	1,090,000	.357	1,080,000	

[1] Based on ovendry weight and volume of 1-inch cross-sectional slice.
[2] Based on volume of entire stud at test corrected to ovendry weight using MC in column 5.
[3] Shortening over 64-inch gage length.
[4] Evaluation by nondestructive flatwise bending test. Values corrected for shear.

RESULTS

Statistics of Population

Only the cores for processes 2, 3, 4, and 5 (fig. 7) belong to the same population. While cores for processes 1, 6, and 7 were randomly selected from the same plywood plant, they were picked on three widely separated days. This feature of the experimental design should be kept in mind while reading the tables of statistical analysis, which treat all cores as a single population. Test results apply only to this limited sample and should not be construed as representative of the species.

Specific Gravity and Rings per Inch of Studs

Specific gravity (ovendry weight and ovendry volume) averaged 0.50 for all 105 studs. Specific gravities of studs evaluated in bending, compression, and tension were: 0.51, 0.50, and 0.48. These values were not significantly different (in this study, significance was tested at the 0.05 level). For reasons not clear, the studs made from cores dried round were lower in specific gravity than the average (0.46); the studs dried under restraint and the laminated studs were higher in specific gravity than the average (both at 0.53). Specific gravity values are tabulated for each stud in table 17, column 6, and in columns 6 and 7 of tables 18 and 19.

Growth rate averaged 3.6 rings per inch for all 105 studs. The studs tested in edgewise bending, compression, and tension were not significantly different, i.e., 3.7, 3.6, and 3.5 rings per inch respectively. The skragged studs had more growth rings per inch than the others, i.e., 5.2, while the studs cut from cores dried round had only 2.9 rings per inch.

Strength Properties

Ultimate stress values had fair positive correlation with specific gravity and with rings per inch of growth rate. For reasons not clear, MOE values were not significantly correlated with specific gravity but were positively correlated with rings per inch. In table 20, the simple regression expressions are followed by the applicable r^2 value. Thirty-five observations established each equation, except that the two expressions relating flatwise MOE to specific gravity and growth rate were each based on 105 observations.

MOE measured nondestructively in flatwise bending (column 13, tables 17, 18, and 19) did not differ significantly among the three test-mode groupings; the average for all 105 studs was 1,230,000 p.s.i.

MOE measured in flatwise bending—and in edgewise bending—did, however, vary significantly with manufacturing process. The good performance of the skragged studs is explained

Table 20.—*Relationship of ultimate stress and MOE to specific gravity and rings per inch*

Y	X	Equation	r^2
Ultimate tensile stress	Specific gravity [1]	$\hat{Y} = -2,406 + 10,858X$	0.26
Ultimate compression stress	Specific gravity [1]	$\hat{Y} = -334 + 10,481X$	.37
MOR edgewise	Specific gravity [2]	$\hat{Y} = -438 + 10,983X$	.23
MOE tension	Specific gravity [1]	Not significant	
MOE compression	Specific gravity [1]	Not significant	
MOE edgewise	Specific gravity [2]	Not significant	
MOE flatwise	Specific gravity [1]	Not significant	
Ultimate tensile stress	Rings per inch	$\hat{Y} = 1,658 + 344X$	.21
Ultimate compression stress	Rings per inch	$\hat{Y} = 3,589 + 340X$	.46
MOR edgewise	Rings per inch	$\hat{Y} = 2,923 + 618X$	.35
MOE tension	Rings per inch		.30
MOE compression	Rings per inch		.37
MOE edgewise	Rings per inch		.27
MOE flatwise	Rings per inch	$\hat{Y} = 919,395 + 85,882X$	.28

[1] Volume at test and ovendry weight.

[2] Because of lack of data, ovendry volume and ovendry weight were used in lieu of the more accurate determination based on volume at test and ovendry weight. Better data would probably have yielded a higher r^2 value.

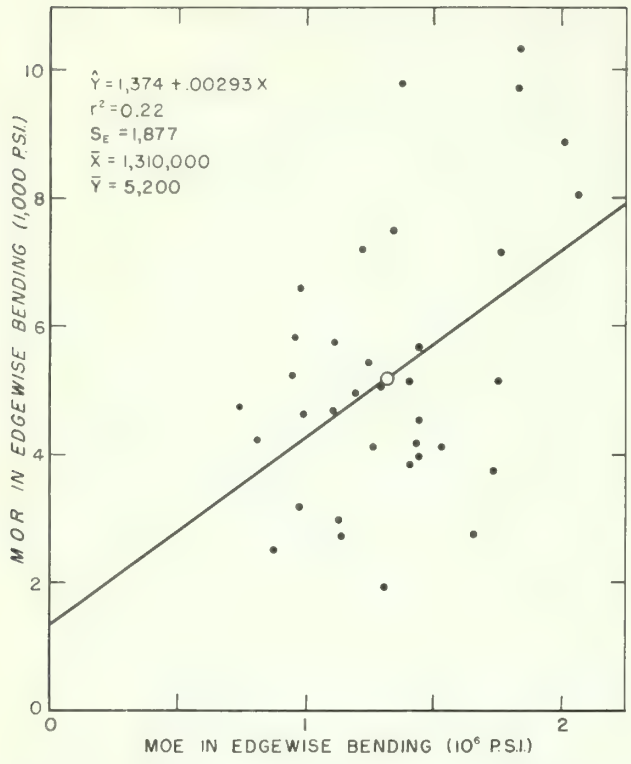
$\hat{Y}$ = 1,374 + .00293 X
r^2 = 0.22
S_ϵ = 1,877
$\bar{X}$ = 1,310,000
$\bar{Y}$ = 5,200
MOR IN EDGEWISE BENDING (1,000 P.S.I.)
MOE IN EDGEWISE BENDING (10^6 P.S.I.)

Figure 32.—*Regression of MOR in edgewise bending on MOE in edgewise bending.*

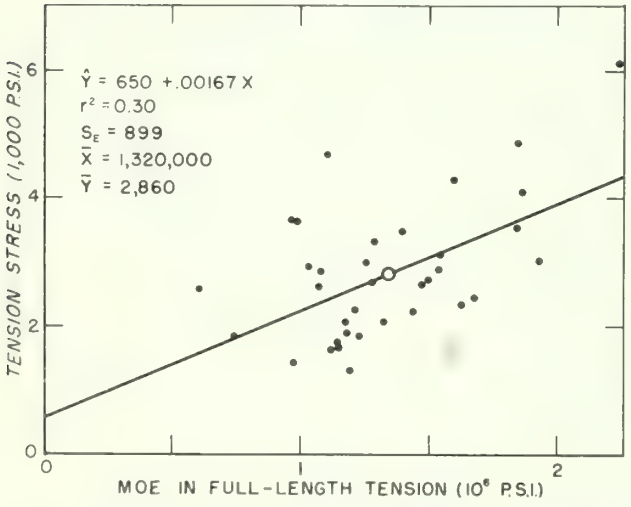

Figure 33.—*Regression of full-length ultimate tension stress on MOE in full-length tension.*

It would appear that MOE measured in the mode of intended load application is a better predictor of ultimate strength than MOE measured in flatwise bending, although in full-length compression both predictors were of comparable efficiency.

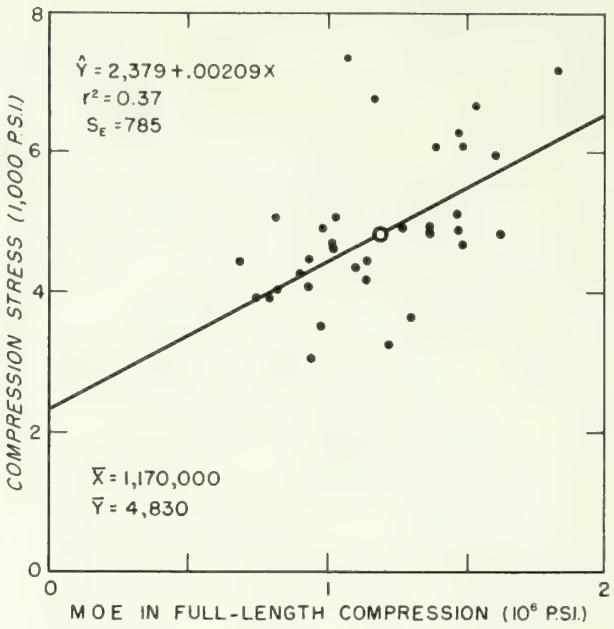
$\hat{Y}$ = 2,379 + .00209 X
r^2 = 0.37
S_ϵ = 785
$\bar{X}$ = 1,170,000
$\bar{Y}$ = 4,830
COMPRESSION STRESS (1,000 P.S.I.)
MOE IN FULL-LENGTH COMPRESSION (10^6 P.S.I.)

Figure 34.—*Regression of full-length ultimate compression stress on MOE in full-length compression.*

Table 22 relates SPIB grade to MOE and to ultimate stress. As expected, stiffness and strength decreased with each decrease in grade. Because of the low specific gravity, the high percentage of juvenile wood, and the various methods of manufacture, most of these values are below those to be expected from southern pine studs in general. Doyle and Markwardt,[5] reporting on an extensive sample of 2 by 4's tested at 13-percent MC, found higher values for MOE and MOR, though not for ultimate compressive stress:

SPIB grade	Edgewise bending		Full-length compression	
	MOE	MOR	MOE	Ultimate compressive stress
	P.s.i.	*P.s.i.*	*P.s.i.*	*P.s.i.*
1	1,830,000	9,020	1,844,000	5,430
2	1,540,000	6,510	1,563,000	4,730
3	1,400,000	5,660	1,476,000	4,160

[5] Doyle, D. V., and Markwardt, L. J. Properties of southern pine in relation to strength grading of dimension lumber. U. S. Forest Serv. Res. Pap. FPL-64, 62 pp., illus. (See tables 2 and 5.) U. S. Forest Prod. Lab., Madison, Wisc. 1966.

Table 22.—*Strength of studs by grade and mode of test* [1]

SPIB grade	MOE				Ultimate stress		
	Bending		Full-length compression	Full-length tension	MOR in edgewise bending	Full-length compression	Full-length tension
	Flatwise	Edgewise					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1,000 p. s. i.	*1,000 p. s. i.*	*1,000 p. s. i.*	*1,000 p. s. i.*	*P. s. i.*	*P. s. i.*	*P. s. i.*
No. 1	1,370 (12)	1,160 (4)	1,490 (4)	1,660 (4)	6,940 (4)	6,090 (4)	4,540 (4)
No. 2	1,370 (25)	1,560 (7)	1,360 (8)	1,350 (10)	6,610 (7)	5,470 (8)	2,880 (10)
Stud	1,160 (61)	1,270 (23)	1,070 (21)	1,280 (17)	4,560 (23)	4,320 (21)	2,520 (17)
No. 3	1,080 (6)	970 (1)	940 (2)	1,080 (3)	3,200 (1)	5,180 (2)	2,480 (3)

[1] Numbers in parentheses after each strength value show the number of studs evaluated. Studs from all seven manufacturing methods are included, but 1 of the 105 studs graded SPIB No. 4 and is excluded from these averages. Moisture content at test was 9 percent.

CONCLUSIONS

Two-by-fours cut from a limited sample of southern pine veneer cores had an average MOE of 1,270,000 p.s.i.; MOR in edgewise bending averaged 5,200 p.s.i., ultimate stress in full-length compression 4,830 p.s.i., and ultimate stress in full-length tension 2,860 p.s.i.

Thus, veneer cores can yield 2 by 4's of strength adequate for loads normally imposed on studs. Further, the manufacturing method did not appear to seriously affect strength values.

COMMERCIAL FEASIBILITY

The sequence contemplated for manufacturing 8-foot studs from southern pine veneer cores includes these steps: (1) diversion of 8-foot cores of 5¼-inch minimum diameter to the stud process, (2) center ripping each core with a bandsaw, (3) reducing each green half-log to uniform but oversize width and thickness on a chipping surfacer-edger, (4) kiln-drying the oversize stud-blanks, (5) face-jointing, thicknessing, and straight-line ripping the blanks, (6) double-end trimming, S4S planing, and edge marking, (7) spraying with preservative in wax emulsion with dye, (8) cutting to special length, (9) sorting, and (10) shipping. Commercial equipment, while not previously combined in this sequence, is available to perform these operations. The major steps of this sequence are diagrammed in figure 36 and on the cover.

Cutting dry half-cores into 4-foot lengths and subsequently end-splicing straight 4-foot blanks into 8-foot lengths probably would result in somewhat straighter studs, but it was felt that the process selected would produce reasonably straight 2 by 4's of SPIB Stud grade and better at considerably lower manufacturing cost.

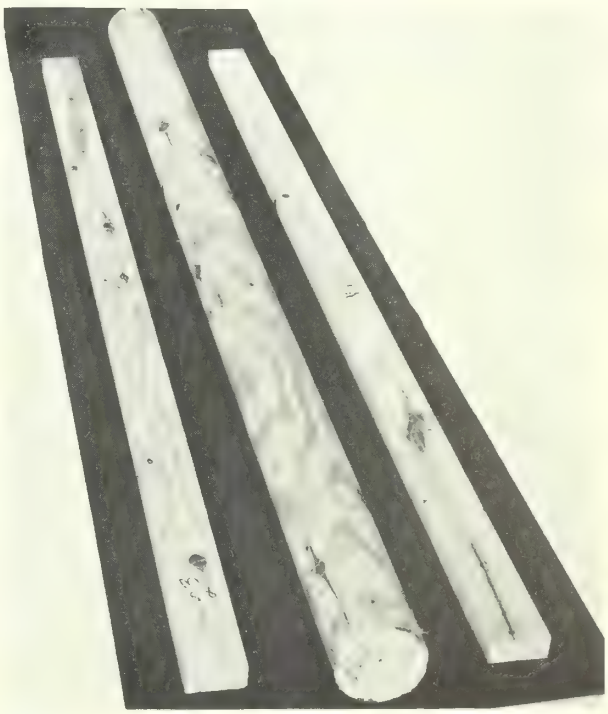

Figure 35.—*Prototype studs made by center-ripping a green veneer core, drying the half-cores, and then extracting a warp-free stud from each half-core by face-jointing, thicknessing, and straight-line ripping.*

grade from which the customer could recover a 2 by 3.

Daily output of the plant would be 5,760 studs, or 30,720 board feet. In addition, approximately 3 tons of pulp chips and 29 tons of dry wood waste—mostly planer shavings—would be accumulated every 24 hours.

ECONOMIC FEASIBILITY

Assessing the economic feasibility of the manufacturing system requires some assumptions about potential markets and economic parameters. At the outset it is assumed that the studs can be sold FOB mill after all discounts and commissions at an average price of $75 per thousand board feet. The dry wood waste should bring $5 per ton and the green pulp chips $6.30 per ton. The raw material cost—i.e., the cost of the core to the stud operation—is assumed to be $0.212 per core, because this is the alternative value as pulp chips.

Gas cost for the direct-fired kilns, wax emulsion with preservative and dye, and electrical energy are assumed to cost $1.50, $0.30, and $2.50 per thousand board feet of studs.

Manpower is estimated as follows: 1 sawmill monitor per shift for three shifts daily, 1 combination kiln operator and setup man on day shift only, 1 feeder for facejointer on day shift only, and 1 offbearer for planer-matcher on day shift only. In addition, forklift time is estimated at 8 man-hours per three-shift day. Maintenance work is estimated at 4 man-hours per three-shift day. Thus the total manpower requirement is 60 man-hours per operating day. As output is 30,720 board feet per day, approximately 2 man-hours are required for manufacturing 1,000 board feet of studs.

Total capital requirement is estimated at $400,000: $100,000 in working capital and $300,000 in plant and equipment chargeable to the stud process.

In table 23, the various technological and economic assumptions are organized to show the annual operating costs and returns. The table indicates annual sales of $863,856 and annual profit before income taxes of $453,504 or 113 percent on an investment of $400,000.

Table 23.—*Estimated annual operating results* [1]

Net sales			
10,752 M board feet of studs at $75 per M		$806,400	
Pulp chips from 1,008,000 cores at $0.006 per core		6,048	
Dry wood waste from 1,008,000 cores at $0.051 per core		51,408	
Net sales			$863,856
Cost of sales			
Raw materials			
1,008,000 cores at $0.212 per core	$213,696		
Gas for kiln-drying 10,752 M at $1.50 per M	16,128		
Power for manufacturing 10,752 M at $2.50 per M	26,880		
Spray material for 10,752 M at $0.30 per M	3,226		
		259,930	
Direct labor for 10,752 M at 2 man-hours per M ($2 per hour)		43,008	
All manufacturing overhead (except depreciation) plus all general and selling overhead at 180 percent of direct labor		77,414	
Depreciation			
$300,000 over 10 years		30,000	
Cost of sales			410,352
Profit before income taxes			$453,504

[1] Assumes that the 8-foot lathe operates three shifts per day, 7 days per week, 50 weeks per year at a sustained rate of two cores per minute.

In assessing these indicated operating results, it should be kept in mind that in some localities cores worth only $0.212 as chips are currently being sold for as much as $0.50 to independent manufacturers of studs and treated fence posts. Plywood manufacturers who are justified in assigning a value of $0.50 per core would still find the proposed stud operation attractive. The indicated annual profit would then be $163,000, or a pretax return of about 41 percent on the $400,000 investment.

In the event the lathe—and hence the sawmill—operated only two shifts per day, 7 days a week, the one-shift facejointing and planing operation would drop from a 7-day week to a more easily scheduled 5-day week. Net sales would be reduced proportionately to $575,904, raw material to $173,286, and labor to $28,672. If it is conservatively assumed that both overhead and depreciation would remain fixed, the profit indicated in table 23 would be reduced to approximately $267,000 per year.

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TREES, SHRUBS, AND WOODY VINES OF THE BLUFF EXPERIMENTAL FOREST, WARREN COUNTY, MISSISSIPPI

Robert L. Johnson and Elbert L. Little, Jr.

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

TREES, SHRUBS, AND WOODY VINES OF THE BLUFF EXPERIMENTAL FOREST, WARREN COUNTY, MISSISSIPPI

Robert L. Johnson[1] and Elbert L. Little, Jr.[2]

Nearly 100 species of trees, shrubs, and woody vines grow naturally on the 450-acre Bluff Experimental Forest in west-central Mississippi. This publication lists the plants and provides information on silvical characteristics of the tree species.

The Bluff Experimental Forest is about 10 miles northeast of Vicksburg (17 miles by road) and 15 miles due east of the Mississippi River in Warren County, Miss. (fig. 1). It lies within Sections 21 and 28, Township 17 North, Range 5 East (Washington Meridian), extending 1½ miles in greatest north-south length and ¾ mile east-west. In 1956 the land was leased for 99 years by the Southern Hardwoods Laboratory[3] of the Southern Forest Experiment Station, U. S. Forest Service, from the Anderson-Tully Company of Vicksburg and Memphis, Tenn. The forest is used for research on methods of planting trees, removing culls, securing natural regeneration, improving utilization, and making harvest cuts.

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[1]Southern Hardwoods Laboratory, Southern Forest Experiment Station, Stoneville, Miss. 38776.

[2]Dendrologist, Division of Timber Management Research, U.S. Forest Service, Washington, D. C. 20250.

[3]The Southern Hardwoods Laboratory, Stoneville, Miss., is maintained by the Southern Forest Experiment Station, U.S. Forest Service, in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

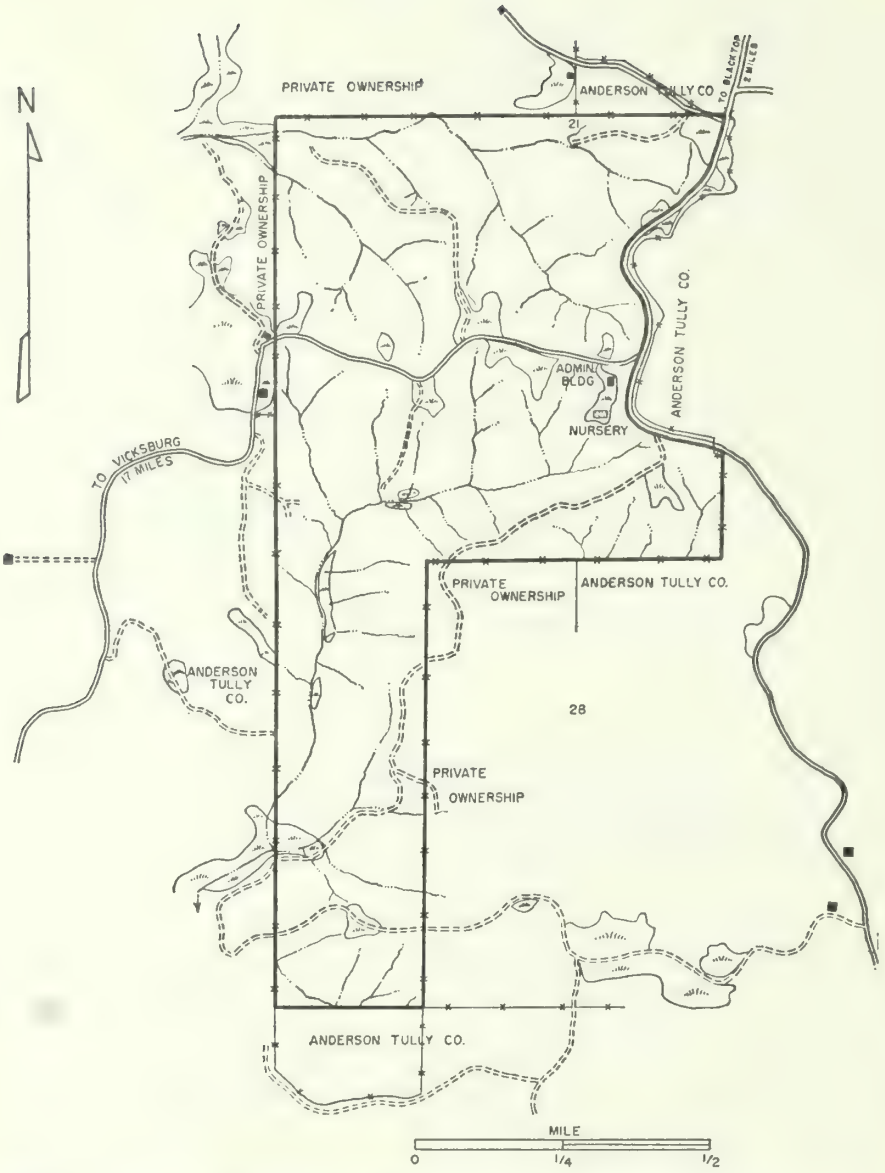

Figure 1.—The 450-acre Bluff Experimental Forest is about 17 miles northeast of Vicksburg in Warren County, Mississippi.

The tract is generally representative of 4½ million acres of forested uplands variously called the Deep Loess area, the Brown Loam Bluffs, the Bluff Hills, or the Bluffs. These uplands are from 5 to 25 miles wide and meander along the eastern edge of the Mississippi River Valley from

Cairo, Ill., to St. Francisville, La. (fig. 2). They consist of windblown deposits of silt loam that are up to 100 feet deep along the river but thin out to the east, finally giving way to the clay and sands common to the uplands of Mississippi and Tennessee. Crowleys Ridge in eastern Arkansas is similar in soil and vegetation.

The Bluff Experimental Forest is on, and most typical of, the deep loess. Its elevation ranges from 240 to 340 feet above sea level. Physiographic features are small drainages with narrow bottoms, gradual to steep slopes to 45 percent gradient, and narrow ridges (fig. 3). No permanent streams occur within the boundaries.

Rainfall at Vicksburg averages 49.5 inches a year. Monthly temperatures range from 49° F. in January to 82° in July and August; they average 66°. The highest temperature recorded since 1885 was 102° and the lowest —2°. The frost-free period extends approximately 7 months from April through October (*4*). This area is approximately in the center of Plant Hardiness Zone 8, which has average annual minimum temperatures of 10° to 20° F. (*5*).

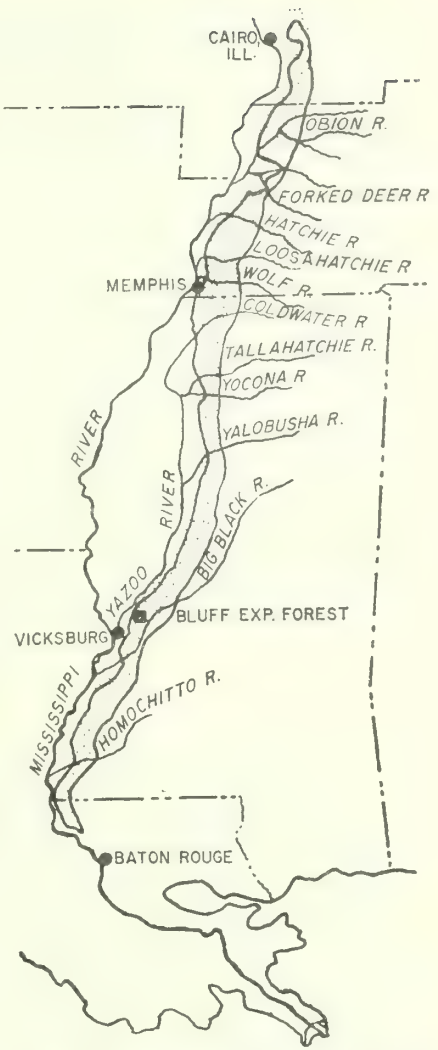

Figure 2.—The Deep Loess area, or Bluff Hills, indicated by the dotted area, comprises 4½ million acres along the eastern edge of the Mississippi River Valley from Illinois to Louisiana.

Except for the steepest slopes, the land now in the forest was farmed for cotton from about 1835 to 1900. A few flat ridgetops and narrow bottoms were in cultivation as late as 1950.

A number of sawtimber cuttings, the last in 1946, removed nearly all the old-growth trees. The present vegetation is upland hardwood forest of mixed species and uneven age (fig. 4). Most of it may be classed within the oak-hickory type. Hardwoods here seem unaffected by aspect

Figure 3.—Narrow bottoms, gradual to steep slopes of up to 45 percent gradient, and narrow ridges characterize the physiography of the Bluff Experimental Forest and the surrounding area.

Figure 4.—Small groups of mixed tree species ranging in size from seedlings to large sawtimber are common to the forests in and around the Bluff Experimental Forest.

and thrive on all sites except eroded ridges with less than 6 inches of topsoil, where pine, primarily loblolly, excels. Well over 50 percent of the commercially valuable trees are oaks. Cherrybark oak is most numerous, followed by southern red oak, Shumard oak, water oak, black oak, white oak, chinkapin oak, and swamp chestnut oak. Lowland species—black willow, cottonwood, green ash, American elm, and sycamore—are found mainly in the wider drainages.

Trees of sawtimber size range from 50 to 80 years old and up to 30 inches in diameter at breast height. An occasional residual is 40 to 60 inches in d.b.h. and 150 to 200 years old. Unusual among the larger trees are a 3-log sassafras 34 inches in d.b.h. and 70-80 years old, and a 4-log cottonwood 30 inches d.b.h. and 40-50 years old.

About 160 herbarium specimens were collected by Elbert L. Little, Jr., and Robert L. Johnson on July 18-21, 1961, and April 15, 1963. Several additional specimens were collected by Johnson in August and September 1963 and in August and September 1965. Identifications were made by Little. Duplicate sets have been deposited in the U.S. Forest Service Herbarium, Washington, D.C.; and in herbaria at the Southern Hardwoods Laboratory, Stoneville, Miss.; headquarters of the Bluff Experimental Forest near Vicksburg, Miss.; and Mississippi State University, Starkville, Miss.

The 97 species of woody plants of the Bluff Experimental Forest include 66 species of trees, 10 of shrubs, and 20 of woody vines. There is one epiphyte or partial parasite. The plants belong to 68 genera in 43 families. Of these species, 93 are native and 5 are introduced. Two of the introduced species (*Lonicera japonica* and *Paulownia tomentosa)* are naturalized, and the others are uncommon escapes from cultivation *(Broussonetia papyrifera, Robinia pseudoacacia,* and *Melia azedarach).* Five additional woody species found nearby are mentioned at the end of the main list (see p. 14). A few more species of shrubs and woody vines may be present within the boundaries in small numbers.

Lowe *(3,* pp. 42-44) has published lists of the characteristic trees, shrubs, and climbers of the loess or bluff area. No unusual records or range extensions were noted at the experimental forest.

The ligneous flora of the bluff area is partly northeastern in relationships, containing many species of Eastern or northeastern United States near their southern limits. All the native woody species of the Bluff Experimental Forest are native also within the area covered by Fernald's revision of Gray's Manual *(1)* except two southeastern tree species *(Magnolia grandiflora* and *Tilia caroliniana),* two shrubby species *(Hydrangea quercifolia*—mentioned as introduced—and *Vaccinium virgatum),* and a vine *(Schisandra glabra). Magnolia grandiflora* here is near its northern limit in the Mississippi Valley. Other Coastal Plain species

of southeastern United States include *Decumaria barbara, Rubus floridus, Styrax grandifolia,* and *Zanthoxylum clava-herculis.*

Because of its small size and limited habitats, the experimental forest obviously lacks some woody species native locally, especially in the bottomland hardwood forests. Warren County borders the Mississippi River and two tributaries, the Yazoo and Big Black Rivers, and has extensive flood plain forests as well as upland.

In the following annotated list, the scientific names and approved common names of trees follow the Forest Service Check List (*2*). Scientific names of shrubs and woody vines are mostly from Fernald (*1*). Local common names have been added where different from those in the Check List or Fernald. Size of mature trees is indicated as large (taller than 70 feet), medium (40 to 70 feet), and small (shorter than 40 feet). Heights by 10-foot intervals and diameters at breast height by 6-inch intervals are estimated for the largest trees of each species on the forest. For species that ordinarily do not reach 6 inches d.b.h., only height estimates are shown. Large shrubs are taller than 5 feet, and small shrubs are less than 5 feet tall. Maximum heights of shrubs are listed where known. Sizes are not indicated for most woody vines. Abundance is listed as abundant, common, uncommon, or rare. Tree species are designated as intolerant, medium tolerant, or tolerant; and growth of medium- and large-sized tree species is classed as fast (at least 4 inches in trunk diameter in 10 years), medium (2-4 inches), or slow (less than 2 inches). Growth rates are applicable mainly to dominant, free-growing individuals.

ANNOTATED LIST

Pinaceae, pine family

Juniperus virginiana L., eastern redcedar, cedar. Medium-sized tree, uncommon, largely in old fields on ridgetops. Medium tolerant, slow-growing. Largest: 70 feet tall, 18 inches d.b.h.

Pinus echinata Mill., shortleaf pine, pine. Large tree, uncommon on Bluff Experimental Forest but planted in adjacent fields. Medium tolerant, medium-growing. Largest: 100 feet tall, 18 inches d.b.h.

Pinus taeda L., loblolly pine, pine. Large tree, common and widespread, mostly on ridges. Medium tolerant, medium-growing. Largest: 100 feet tall, 30 inches d.b.h.

Gramineae, grass family

Arundinaria gigantea (Walt.) Chapm., giant cane, cane. Common large shrub reaching 25-30 feet tall. Most common along drainages but found elsewhere.

Liliaceae, lily family

Smilax glauca Walt., cat greenbrier, sawbrier. This and the two species listed immediately below are woody vines common and widespread

in old fields, along rights-of-way, and in newly created forest openings.

Smilax hispida Muhl., bristly greenbriar.

Simlax rotundifolia L., common greenbrier.

Salicaceae, willow family

Populus deltoides Bartr., eastern cottonwood, cottonwood. Large tree, uncommon, mainly along drainages but not restricted to such. Intolerant, fast-growing. Largest: 120 feet tall, 36 inches d.b.h.

Salix nigra Marsh., black willow, willow. Large tree, uncommon, mainly along drainages but not restricted to such. Intolerant, fast-growing. Largest: 90 feet tall, 18 inches d.b.h.

Juglandaceae, walnut family

Carya cordiformis (Wangenh.) K. Koch, bitternut hickory, hickory. Large tree, common, on upper slopes and ridges but found on all sites. Tolerant, medium-growing. Largest: 80 feet tall, 18 inches d.b.h.

Carya glabra (Mill.) Sweet, pignut hickory, hickory. Large tree, uncommon on upper slopes and ridges but found on all sites. Tolerant, medium-growing. Largest: 80 feet tall, 18 inches d.b.h.

Carya tomentosa Nutt., mockernut hickory, mockernut. Large tree, common on upper slopes and ridges but found on all sites. Tolerant, medium-growing. Largest: 80 feet tall, 18 inches d.b.h.

Juglans nigra L., black walnut, walnut. Large tree, uncommon. Scattered individuals grow best on lower slopes or bottoms. Intolerant, medium-growing. Largest: 80 feet tall, 24 inches d.b.h.

Betulaceae, birch family

Carpinus caroliniana Walt., American hornbeam, ironwood. Small tree, abundant, throughout the understory, often becoming dominant when larger overstory trees are removed. Tolerant. Largest: 40 feet tall, 12 inches d.b.h.

Ostrya virginiana (Mill.) K. Koch, eastern hophornbeam, ironwood. Small tree, abundant, throughout the understory, often becoming dominant when larger overstory trees are removed. Tolerant. Largest: 40 feet tall, 12 inches d.b.h.

Fagaceae, beech family

Fagus grandifolia Ehrh., American beech, beech. Large tree, common, especially on lower slopes. Tolerant, slow-growing, having the oldest individuals of all species of this forest. Largest: 90 feet tall, 36 inches d.b.h.

Quercus alba L., white oak. Large tree, common, mainly on upper slopes and ridges. Medium tolerant, medium-growing. Largest: 90 feet tall, 24 inches d.b.h.

Quercus falcata Michx. var. *falcata,* southern red oak, red oak. Large tree, common, concentrated on ridges but found all over. Medium tolerant, medium-growing. Largest: 100 feet tall, 30 inches d.b.h.

Quercus falcata Michx. var. *pagodaefolia* Ell., cherrybark oak, red oak. Large tree, abundant, the most common tree species on this forest, on all sites. Medium tolerant, fast-growing. Largest: 120 feet tall, 36 inches d.b.h.

Quercus michauxii Nutt., swamp chestnut oak, cow oak. Large tree, uncommon, single trees scattered through the stand. Medium tolerant, medium-growing. Largest: 100 feet tall, 24 inches d.b.h.

Quercus muehlenbergii Engelm., chinkapin oak, white oak. Large tree, uncommon, single trees scattered through the stand. Medium tolerant, medium-growing. Largest: 100 feet tall, 18 inches d.b.h.

Quercus nigra L., water oak. Large tree, common, mostly on ridges, where it tends to produce numerous epicormic branches. Medium tolerant, medium-growing. Largest: 110 feet tall, 30 inches d.b.h.

Quercus phellos L., willow oak, pin oak. Large tree, rare, generally in broad drainages. Medium tolerant, medium-growing. Largest: 80 feet tall, 12 inches d.b.h.

Quercus shumardii Buckl., Shumard oak, striped oak. Large tree, common, the second most common red oak, found with cherrybark oak on all sites. Largest: 120 feet tall, 36 inches d.b.h.

Quercus velutina Lam., black oak. Large tree, common, mostly on upper slopes and ridges. Medium tolerant, of medium growth rate. A few trees may be hybrids, apparently with *Quercus falcata,* which large trees resemble. Largest: 100 feet tall, 24 inches d.b.h.

Ulmaceae, elm family

Celtis laevigata Willd., sugarberry, hackberry. Large tree, uncommon, generally found in the wider bottoms. Tolerant, of medium growth rate. Largest: 60 feet tall 18 inches d.b.h.

Ulmus alata Michx., winged elm, cork elm. Large tree, common, most numerous on upper slopes and ridges. Tolerant, of medium growth rate. Largest: 90 feet tall, 18 inches d.b.h.

Ulmus americana L., American elm, elm. Large tree, common in wider bottoms and lower slopes. Tolerant, of medium growth rate. Largest: 100 feet tall, 30 inches d.b.h.

Ulmus rubra Muhl., slippery elm. Large tree, uncommon, only scattered trees, generally on the slopes. Tolerant, of medium growth rate. Largest: 100 feet tall, 18 inches d.b.h.

Moraceae, mulberry family

Broussonetia papyrifera (L.) Vent. Very rare introduced tree, one planted near old home site.

Morus rubra L., red mulberry, mulberry. Small to medium-sized tree, common, generally in the understory. Tolerant. Largest: 40 feet tall, 12 inches d.b.h.

Loranthaceae, mistletoe family

Phoradendron serotinum (Raf.) M. C. Johnston (*Ph. flavescens* auth.). Small shrubby epiphyte and partial parasite with leathery evergreen leaves, on trees of many species.

Menispermaceae, moonseed family

Cocculus carolinus (L.) DC., Carolina snailseed, Carolina moonseed. Woody vine with bright red berries, common, mostly in and around openings in the forest.

Magnoliaceae, magnolia family

Liriodendron tulipifera L., yellow-poplar, poplar. Large tree, common, growing best on the slopes. Exhibits very fast early growth in forest openings. Intolerant. Largest: 120 feet tall, 30 inches d.b.h.

Magnolia acuminata L. (var. *acuminata),* cucumbertree, cucumber. Large tree, uncommon. Scattered single trees most numerous on lower slopes. Intolerant, medium-growing. Largest: 90 feet tall, 24 inches d.b.h.

Magnolia grandiflora L., southern magnolia, magnolia. Large tree, common on narrow drainages and lower slopes. Medium tolerant, medium-growing. Largest: 80 feet tall, 30 inches d.b.h.

Schisandra glabra (Brickel) Rehd. *(S. coccinea* Michx.), Carolina magnolia-vine. This rare vine was seen but not in flower.

Annonaceae, annona family

Asimina triloba (L.) Dunal, pawpaw. Small understory tree seldom exceeding 30 feet tall, common. Tolerant.

Lauraceae, laurel family

Lindera benzoin (L.) Blume, spicebush. Large aromatic shrub reaching height of 10-15 feet. Common, generally in the understory along drainages.

Sassafras albidum (Nutt.) Nees, sassafras. Large tree, common on slopes and in the bottoms. A pioneer on old eroded ridges but rarely grows well there. Intolerant, medium-growing. Largest: 100 feet tall, 36 inches d.b.h.

Ranunculaceae, crowfoot family

Clematis virginiana L., virgin's-bower. Climbing vine, common.

Saxifragaceae, saxifrage family

Decumaria barbara L., southeast decumaria. Climbing vine to 50 feet, common.

Hydrangea arborescens L. (var. *arborescens),* smooth hydrangea, hydrangea. Large shrub to 10 feet tall, growing singly or in clumps, common.

Hydrangea quercifolia Bartr., oakleaf hydrangea, hydrangea. Large shrub to 10 feet tall, growing singly or in clumps, common. The large leaves are conspicuous.

Hamamelidaceae, witch-hazel family

Hamamelis virginiana L., witch-hazel. Small tree seldom taller than 30 feet, abundant, on most sites, generally in the understory. Tolerant.

Liquidambar styraciflua L., sweetgum. Large tree, abundant, the second most common tree species, behind cherrybark oak. Found on all sites but grows poorly on eroded ridgetops. Intolerant, medium-growing. Largest: 120 feet tall, 36 inches d.b.h.

Platanaceae, sycamore family

Platanus occidentalis L., American sycamore, sycamore. Large tree, uncommon, found only along the drainages. Intolerant, medium-growing. Largest: 100 feet tall, 24 inches d.b.h.

Rosaceae, rose family

Crataegus viridis L., green hawthorn, haw. Small tree, up to 20 feet tall, often found in the understory, also common on old fields. Tolerant.

Prunus angustifolia Marsh., Chickasaw plum, tame plum. Small tree, up to 20 feet tall, common along rights-of-way and in old fields. Intolerant.

Prunus mexicana S. Wats., Mexican plum, wild plum. Small tree, up to 20 feet tall, common along rights-of-way and in old fields. Intolerant.

Prunus serotina Ehrh. (var. *serotina),* black cherry, cherry. Large tree, common. Found on most sites but grows best on slopes. Tolerant, medium-growing. Largest: 80 feet tall, 36 inches d.b.h.

Rubus floridus Tratt., blackberry. Bramble shrub and vine, reaching heights of 6 feet, common, forming thickets in forest openings and along rights-of-way.

Leguminosae, legume family

Cercis canadensis L., eastern redbud, redbud. Small tree, common, on most sites, generally in the understory. Tolerant. Largest: 40 feet tall, 6 inches d.b.h.

Gleditsia triacanthos L., honeylocust. Large tree, uncommon, generally occurs along drainages as a single tree. Intolerant, slow-growing. Largest: 80 feet tall, 18 inches d.b.h.

Robinia pseudoacacia L., black locust. Medium-sized tree, introduced, uncommon, rarely large. Only known concentration of saplings occurs along main gravel road about ½ mile west of the headquarters building. Intolerant, slow-growing. Largest: 30 feet tall, 6 inches d.b.h.

Rutaceae, rue family

Zanthoxylum clava-herculis L. (var. *clava-herculis),* Hercules-club, toothache-tree. Small tree, common, mainly along drainages and on lower slopes. Tolerant. Largest: 50 feet tall, 12 inches d.b.h.

Meliaceae, mahogany family

Melia azedarach L., chinaberry. Medium-sized tree, introduced, uncommon. Planted as shade tree around homes, escaping along roadsides,

and rare in the forest. Intolerant, slow-growing. Largest: 60 feet tall, 18 inches d.b.h.

Anacardiaceae, cashew family

Rhus copallina L. (var. *copallina),* shining sumac, sumac. Small tree, common in old fields, along rights-of-way, and in large forest openings. Intolerant. Largest: 30 feet tall, 6 inches d.b.h.

Rhus glabra L., smooth sumac, sumac. Small tree, common in old fields, along rights-of-way, and in large forest openings. Intolerant. Largest: 30 feet tall, 6 inches d.b.h.

Rhus radicans L. *(Toxicodendron radicans* (L.) Kuntze), poison-ivy. Woody vine, common, widespread on the ground and on trees.

Aquifoliaceae, holly family

Ilex decidua Walt., possumhaw, deciduous holly. Small tree, to about 12 feet tall, uncommon, generally single tree along drainages. Tolerant.

Ilex opaca Ait., American holly, holly. Medium-sized tree, uncommon, scattered over the forest but seldom on upper slopes and ridges. Tolerant, slow-growing. Largest: 50 feet tall, 12 inches d.b.h.

Celastraceae, bittersweet family

Celastrus scandens L., American bittersweet. Woody vine, common, on most sites.

Euonymus americanus L., brook euonymus, wahoo. Large shrub to 8 feet high, common, mostly along drainages.

Aceraceae, maple family

Acer barbatum Michx. (*A. floridanum* (Chapm.) Pax), Florida maple, maple. Medium-sized tree, common to abundant in the understory, rarely large. Tolerant, slow-growing. Largest: 70 feet tall, 18 inches d.b.h.

Acer negundo L., boxelder. Medium-sized tree, common, mainly along drainages. Tolerant, slow-growing. Largest: 60 feet tall, 18 inches d.b.h.

Acer rubrum L. (var. *tridens* Wood), red maple, maple. Medium-sized tree, common to abundant in the understory, rarely large. Tolerant, medium-growing. Largest: 50 feet tall, 12 inches d.b.h.

Rhamnaceae, buckthorn family

Berchemia scandens (Hill) K. Koch, Alabama supplejack. Large woody vine to 50 feet high and 1 inch in diameter, common.

Rhamnus caroliniana Walt., Carolina buckthorn. Small tree growing to about 30 feet tall, uncommon, generally found on the slopes. Tolerant.

Vitaceae, grape family

Ampelopsis arborea (L.) Koehne, peppervine, buckvine. Woody vine, common, normally found in large openings.

Parthenocissus quinquefolia (L.) Planch., Virginia-creeper. Woody vine, common in the understory or climbing on trees.

Vitis aestivalis Michx., summer grape, grape. Large climbing woody vine, common.

Vitis riparia Michx., riverbank grape, grape. Large climbing woody vine, common.

Vitis rotundifolia Michx., muscadine. Large climbing woody vine, common.

Vitis vulpina L., frost grape, grape. Very large climbing vine, uncommon. Grape vines grow to 50 feet high and 6 inches in diameter.

Tiliaceae, basswood or linden family

Tilia caroliniana Mill., Carolina basswood, linn. Large tree, common. Prolific sprouter occurring on most sites. Medium tolerant, medium-growing. Largest: 100 feet tall, 24 inches d.b.h.

Guttiferae, mangosteen family

Ascyrum hypericoides L. var. *hypericoides (Hypericum hypericoides* (L.) Crantz), St. Andrews-cross. Small shrub 1-3 feet high, common on the forest floor.

Araliaceae, ginseng family

Aralia spinosa L., devils-walkingstick. Small tree, to about 30 feet tall, common, invading newly created forest openings. Intolerant. Fast initial growth, but soon becomes suppressed by other trees.

Cornaceae, dogwood family

Cornus drummondii C. A. Meyer, roughleaf dogwood, dogwood. Shrub or small tree, to about 20 feet tall, uncommon, at edge of openings and along drainages. Tolerant.

Cornus florida L., flowering dogwood, dogwood. Small tree, abundant throughout the understory. Tolerant. Largest: 40 feet tall, 6 inches d.b.h.

Nyssa sylvatica Marsh., black tupelo, blackgum. Large tree, uncommon. Scattered large trees mainly on the slopes. Reproduction general. Intolerant, slow-growing. Largest: 80 feet tall, 24 inches d.b.h.

Ericaceae, heath family

Vaccinium arboreum Marsh.. tree sparkleberry. Small tree, to about 20 feet tall. Rare, found only around site of an old home on the north side of the forest.

Vaccinium virgatum Ait., huckleberry. Small shrub 3-5 feet high, uncommon, found mainly around sites of old homes or along rights-of-way in dry upland.

Sapotaceae, sapodilla family

Bumelia sp., bumelia. One small tree 20 feet high and 3 inches d.b.h., the only one known on this forest, grew in the dry upland along a roadside and was destroyed.

Ebenaceae, ebony family

Diospyros virginiana L., common persimmon, persimmon. Large tree, common and general over forest. Reproduction common on old fields and

along rights-of-way. Intolerant, slow-growing. Largest: 80 feet tall, 12 inches d.b.h.

Styracaceae, snowbell or storax family

Styrax grandifolia Ait., bigleaf snowbell, snowbell. Small tree growing to about 20 feet tall, common, especially along drainages. Tolerant.

Symplocaceae, sweetleaf family

Symplocos tinctoria (L.) L'Her., common sweetleaf. Small evergreen tree reaching about 20 feet tall, uncommon, general. Tolerant.

Oleaceae, olive family

Fraxinus americana L., white ash. Large tree, common. Tolerant, medium-growing. Largest: 110 feet tall, 30 inches d.b.h.

Fraxinus pennsylvanica Marsh., green ash. Large tree, common along wider drainages. Tolerant, medium-growing. Largest: 90 feet tall, 18 inches d.b.h.

Apocynaceae, dogbane family

Trachelospermum difforme (Walt.) A. Gray, star-jasmine, climbing dogbane. Entwining vine, common.

Verbenaceae, verbena family

Callicarpa americana L., American beautyberry. Large shrub reaching about 10 feet tall, occurring singly or in clumps, common.

Bignoniaceae, bignonia family

Bignonia capreolata L. *(Anisostichus capreolata* (L.) Bureau), crossvine, buckvine. Woody climbing vine, common, general.

Campsis radicans (L.) Seem., trumpet-creeper. Woody vine, common in large openings and along rights-of-way.

Paulownia tomentosa (Thunb.) Sieb & Zucc., royal paulownia, bluebell. Large tree, introduced, common. Planted near old home sites and now naturalized and general over the forest. Largest: 70 feet tall, 24 inches d.b.h.

Caprifoliaceae, honeysuckle family

Lonicera japonica Thunb., Japanese honeysuckle, honeysuckle. Woody vine, introduced and naturalized. Common in forest openings along drainages and rights-of-way.

Sambucus canadensis L., American elder, elder. Small tree, invading forest openings and growing up to about 30 feet tall quickly. Common. Found mainly along drainages. Intolerant.

Viburnum rufidulum Ra., rusty blackhaw. Small understory tree growing to about 20 feet tall, uncommon. General. Tolerant.

Compositae, composite family

Baccharis halimifolia L., eastern baccharis. Small shrub, rare.

ADDITIONAL SPECIES NEARBY

Carya illinoensis (Wangenh.) K. Koch, pecan, sweet pecan. Large tree, planted in many locations. Native in Mississippi River bottom lands and westward. Tolerant, medium-growing.

Castanea alnifolia Nutt. var. *floridana* Sarg., Florida chinkapin, chinkapin. Medium-sized tree to 50 feet high and 20 inches d.b.h. Only two known trees on ridge near the site of an old home, 4 miles northeast of Bluff Experimental Forest.

Maclura pomifera (Raf.) Schneid., Osage-orange, mockorange, bodock, horse-apple. Medium-sized tree, introduced. Planted and escaping from cultivation. Widely scattered in areas around Bluff Experimental Forest. Tolerant, slow-growing.

Magnolia macrophylla Michx., bigleaf magnolia, magnolia. Small tree, fairly common to area around Bluff Experimental Forest, occurring in nearly a pure stand in one abandoned field. Tolerant, slow-growing.

Ptelea trifoliata L. (var. *trifoliata),* common hoptree, hoptree. Large shrub 5-15 feet tall, uncommon. One found 1 mile west of Bluff Experimental Forest, and others in the area.

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R. E. Farmer, Jr., and J. S. McKnight

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POPULUS: A BIBLIOGRAPHY OF WORLD LITERATURE, 1854-1963

R. E. Farmer, Jr., and J. S. McKnight

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

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POPULUS: a bibliography of world literature, 1854-1963

R. E. Farmer, Jr., and J. S. McKnight [1]

This bibliography is intended as a comprehensive reference for international use by researchers and land managers.

The impetus for its preparation came from the Poplar Council, an organization formed in 1964 by U. S. industrial and public foresters to advance knowledge of poplar culture, encourage planting and management of poplars, and stimulate utilization of the wood.

The Council decided soon after its formation that an English-language bibliography would be useful. It thereupon appealed to the Commonwealth Forestry Bureau, Oxford, England, for permission to use the references and abstracts that had been accumulated in connection with the publication of **Forestry Abstracts.** The Bureau responded by furnishing, at nominal cost, the citations and annotations printed here. There remained the task of classifying and arranging the citations, and that was undertaken by the present authors.

The bibliography is arranged first by species or groups of species, then by subject-matter categories. About half the references deal with poplars in general or with several species; these are grouped under the head *Populus spp.* A conspectus of primary subject-matter heads and subheads is included as a Key to Subject-Matter Classification. Numerals in the Key and preceding the citations refer to subject-matter assignments based upon the **Oxford System of Decimal Classification for Forestry**, the authorized English version of which was published by the Commonwealth Agricultural Bureaux, Farnham Royal, England.

To most efficiently use the bibliography, the reader should refer first to the Table of Contents for species and then to the Key for subject matter. Information on titles of publications cited and other aspects of the citation entries will be found in **Guide to the Use of Forestry Abstracts,** also available from the Commonwealth Agricultural Bureaux.

[1] The authors are on the staff of the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the U. S. Forest Service in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

Key to Subject-Matter Classification

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- 15 Animal Ecology
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  - 237 Amelioration of Forest Sites
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165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

Piccarolo, G. 1937. ATTIVITA DELL' ISTITUZIONE MIGLIORAMENTO PIOPPO (1936-7) E STAZIONE SPERIMENTALE DI PIOPPICOLTURA. [ACTIVITIES OF THE INSTITUTE FOR POPLAR BREEDING (1936-7) AND THE POPLAR CULTIVATION EXPERIMENT STATION.] In Atti del Convegno di Pioppicoltura 1937: 133-59. [It.]

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Regnier, R. 1955. DE L'ORIGINE DES PEUPLIERS. [THE ORIGIN OF THE POPLARS.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-B, 5 pp. [F.]
Gives a short account of fossil species, and discusses the evolution of the various sections of Populus.

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Artaza, J. E. 1955. GENETIQUE ET SELECTION DES PEUPLIERS ESPAGNOLES. [GENETICS AND SELECTION OF SPANISH POPLARS.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 1, 6 pp. [F.]
A short account of the indigenous poplars and natural hybrids, and the hybrid American poplars used for breeding in Spain.

Bingham, R. T. 1963. PROBLEMS AND PROGRESS IN IMPROVEMENT OF RUST RESISTANCE OF NORTH AMERICAN TREES. [Pap.] FAO World Consult. For. Genet., Stockh. 1963. No. FAO/FORGEN 63/-6a/1, 12 pp. 62 refs.
Reviews the breeding now in progress to obtain Melampsora-resistant poplars, Peridermium-harknessii- and Cronartium- fusiforme-resistant hard pines, and C.-fusiforme-resistant white pines.

Bogdanov, P. L. 1951. ITOGI RABOTY PO SELEKCII TOPOLEI V LENINGRADE. [SELECTION AND BREEDING OF POPLARS AT LENINGRAD.] Trud. Inst. Les. No. 8: 72-7. 5 refs. [Russ.]
A review in general terms of work so far done and methods used.

Elorrieta y Artaza, J. 1960. ESTUDIOS DE MEJORA DE LOS CHOPOS MAS INTERESANTES PARA ESPANA. [THE IMPROVEMENT OF POPLARS OF MOST INTEREST TO SPAIN.] Montes, Madrid 16(92): 115-31. [Span.]
Presents a short survey of the botanical and silvicultural characteristics of the genus, and gives a history of poplar breeding in Spain, reviewing in some detail the work of the regional forest departments and of the Madrid Forest Research Institute.

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Heimburger, C. 1951. REPORT ON FOREST TREE BREEDING: POPLAR. Progr. Rep. Field Lab. Proj. Ont. Dep. Lds. For. 1950/51: 50-3.

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FORESTRY AND AGRICULTURE OR HORTICULTURE. II. POPLAR BREEDING IN THE NETHERLANDS. I. Euphytica 1(1): 10-4. 7 refs. [E.du.] II. Euphytica 1(3): 161-74. 10 refs. [E.du.]

[International: World For. Congr. 1960] 1962. [SELECTION AND BREEDING OF POPLARS IN ITALY. Proc. 5th World For. Congr., Seattle, 1960. Vol. 2 (Sect. 2): 806-8, 811-4. 5 refs. [E. or F., f. or e. span.]
Includes: Observations on the selection of poplars of the section Leuce in Italy (M. Sekawin [F.]); recent work on Populus deltoides in Italy (E. Giordano [E.]); and some observations of the morphology and classification of Populus tremula L. in Italy (G. Gramiglio [E.]).

[Italy: Cellulosa e Carta] 1953. L'ATTIVITA 1952-1953 DELL'ISTITUTO DI SPERIMENTAZIONE PER LA PIOPPICOLTURA DI CASALE MONFERRATO. [ACTIVITY OF THE POPLAR RESEARCH INSTITUTE AT CASALE MONFERRATO DURING 1952-3.] Cellulosa e Carta 4(5): 10-1. [It.]
Deals mainly with artificial hybridization, particularly the use of pollen from a polyploid form of "P. euramericana clone 438" for crossing with two clones of P. angulata, one of P. nigra and "P. euramericana I 214." The pollen of this polyploid has larger grains and more variation in size of grains than the diploid female parent, and germinability increased by one-third.

Jovanovic, B. 1959. NEKA ISKUSTVA I ZADACI OPLEMENJIVANJA TOPOLA KOD NAS. [EXPERIENCE AND TASKS IN POPLAR BREEDING IN YUGOSLAVIA.] Topola, Beograd 3(11): 877-93. 16 refs. [Serb.f.]
Summarizes some recent research, and discusses the setting up of a section concerned with breeding, under the Yugoslav National Poplar Commission.

[Jugoslavia: Topola] 1959. IZBOR I EVIDENCIJA POLAZNIH TOPOLOVIH STABALA ZA DALJU SELEKCIJU. [CHOICE OF THE FIRST POPLAR TREES FOR FURTHER SELECTION, AND THE RECORDING OF INFORMATION ON THEM.] Topola, Beograd 3(12): 986-99. 7 refs. [Serb.]
Indicates the characters desirable in such poplars and presents a detailed form for recording particulars of outstanding trees, with instructions on how to complete it. The form is a draft submitted to the sub-group for selection and breeding of the Yugoslavian National Poplar Commission.

———— 1959. UPUTSTVA ZA PRAKTICNO IZVODENJE SELEKCIJE TOPOLA. [INSTRUCTIONS FOR PRACTICAL WORK IN POPLAR BREEDING.] Topola, Beograd 3(12): 1004-16. [Serb.]
Gives detailed instructions, based on Italian methods, on the actual steps to be taken in poplar breeding, with diagrams showing desirable tree characteristics and nursery lay-out.

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Knezevic, I. 1958. METODOLOGIJA SELEKCIJE TOPOLA. [METHODS OF POPLAR SELECTION.] Sum. List 82(1/2): 38-42. 2 refs. [Croat.]
Describes methods practiced at the Istituto di Sperimentazione per la Pioppicoltura, Casale Monferrato, Italy.

Kopeczky, F. 1952. (1954). ERDESZETI GENETIKA ES HAZAI NYARNEMESITES. [FOREST GENETICS AND PLANT BREEDING IN HUNGARY.] Erdesz. Tud. Int. Evk., Budapest 2:51-65. [Hu.]
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A detailed account of methods employed and results obtained in poplar breeding by the Institut de Populiculture, Union Alumettiere, Grammont.

Martinez Mata, F., and Zuloaga Roman, A. 1957. SECCION DE GENETICA FORESTAL. [FOREST GENETICS SECTION.] An. Inst. For. Invest. Exp., Madrid No. 2:27-30. [Span.]
Reports work in progress, mainly on pines and poplars.

Nemec. 1926. THE DESCENDANTS OF SOME FEMALE PYRAMIDAL POPLARS. Bot. Abstr. 15: 7634.

[Netherlands: Ned. Boschb.-Tijdschr.] 1957. DE VEREDELING IN DE BOSBOUW IN NEDERLAND. [TREE BREEDING IN FORESTRY IN THE NETHERLANDS.] Ned. Boschb.-Tijdschr. 29(3;4): 53-81; 91-121. [Du.e.]

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Rovskii, V. M. 1951. SELEKCIJA LESNYH POROD V UZBEKISTANE. [SELECTION AND BREEDING OF TREE SPECIES IN UZBEKISTAN.] Trud. Inst. Les. No. 8: 132-51. 15 refs. [Russ.]
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———— 1961. LA SELEZIONE E LA COLTURA DEL PIOPPO NELL 'UNIONE SOVIETICA. [THE BREEDING AND GROWING OF POPLARS IN THE U.S.S.R.] Cellulosa e Carta 12(7): 5-10. [It.f.e.g.]
Deals particularly with work on polyploid aspen, and hybrids of the section turanga, which are very resistant to drought.

———— 1963. [POPLAR GENETICS.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-4/4, 6 pp. 11 refs. [F.f.]
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———— 1963. [THE GENETIC IMPROVEMENT OF POPLAR IN ITALY.] Cellulosa e Carta 14(8): 5-13. 9 refs. [It.f.e.g.]
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———— and Riker, A. J. 1954. BREEDING POPLARS FOR DISEASE RESISTANCE. Abstr. in Phytopathology 44(9): 505.

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Tyszkiewicz, S. 1952. SELEKCJA TOPOLI W ZAKLADZIE NASIENNICTWA. [SELECTION OF POPLARS IN THE SEED RESEARCH SECTION [OF THE FOREST RESEARCH INSTITUTE, WARSAW].] Sylwan 96(4): 469-72. [Pol.]
Describes work done since February 1951 on P. tremula (artificial pollination) and P. euroamericana × P. nigra italica (seeds and seedlings).

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A brief review of the author's work on Populus, Pinus sylvestris, Picea abies, and Larix decidua.

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The studies concern systematy and breeding.

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Discusses conclusions reached from observation of 184 combinations of crosses (50,000 hybrid seedlings) made in 1950-55.

Bogdanov, P. L. 1960. RAZMERY DREVESNYH VOLOKON U GIBRIDNYH TOPOLEJ. [FIBRE DIMENSIONS OF HYBRID POPLARS.] Lesn. Z., Arhangel'sk 3(1): 29-30. [Russ.]
Presents the results of some Soviet measurements on 14 species and hybrids, and points out the excellent properties of Populus × 'Leningrad'.

[Czechoslovakia] 1951. PROSTY ZPUSOB GENERATIVNIHO KRIZENI TOPOLU. [A SIMPLE METHOD OF POPLAR HYBRIDIZATION.] Csl. Les 31(12): 274-5. [Cz.]

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The work described was begun in 1955 as part of the program of the Croatian Institute of Forest and Game Research, Zagreb. Data on the origin and growth of hybrids obtained by controlled hybridization and by open pollination are tabulated, and recommendations for future research given. [Cf. Jovanovic and Tucovic, 1960, this subject classification.]

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A longer article than that noticed above, with illustrations.

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Summarizes the experience of the authors in poplar breeding since 1956, with recommendations on methods and choice of material. Data on crosses produced and first-year growth of the 14 most successful hybrids raised in 1960 are tabulated. [Cf. Jovanovic and Tucovic, 1960, above, and Jovanovic, 1959, Populus sp., 165.3]

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Describes methods of controlled crossing using the cut-branch technique and of grafting to produce dwarf plants for crossing experiments, with special reference to Populus alba, P. tremuloides, and P. "Bachofeni."

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Meyer-Uhlenried, K.-H. 1958. UNTERSUCHUNGEN UBER DIE VERERBUNG EINES ANATOMISCHEN MERKMALS BEI KREUZUNGEN VON PAPPELN VERSCHIEDENER SEKTIONEN. [INVESTIGATIONS OF THE TRANSMISSION OF AN ANATOMICAL FEATURE IN CROSSINGS OF POPLARS OF DIFFERENT SECTION.] Zuchter 28(5): 209-16. 20 refs. [G.g.] Transl. by J. Hardy, Commonw. Sci. Industr. Res. Organ. Aust. No. 4227, 19 pp. 1960.

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A monograph on poplar hybridization in Poland, covering theoretical premises, methods, the breeding stock, and the hybrids obtained. Many of the salient points are given in the four-page English summary.

[U.S.A.: Ntheast. For Exp. Sta.] 1960 HYBRID POPLAR GROWTH RATES CORROLATED WITH ROOT ANATOMY. Extr. From Rep. U. S. For. Serv. Ntheast. For. Exp. Sta. 1959: 18.

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Includes notes on breeding experiments on Quercus, Populus (including a tabulated summary of species crosses), and Fraxinus.

Zurbin, A. I. 1951. VYVEDENIE NOVYH GIBRIDOV TOPOLEI. [NEW POPLAR HYBRIDS.] Trud. Inst. Les. No. 8: 78-84. 13 refs. [Russ.]
Includes a list of 50 attempted crossings made by the author in the Ukraine, 1947-49, with notes on methods used and on the hybrids produced.

———— 1951. PREODOLENIE NESKRESCIVAEMOSTI VIDOV TOPOLEI PRI POMOSCI PONIZENNYH TEMPERATUR I TEMNOTY. [OVERCOMING BARRIERS TO CROSSING IN POPLAR SPECIES BY MEANS OF LOWERED TEMPERATURES AND DARKNESS.] Trud. Inst. Les. No. 3: 85-7. [Russ.]
Reports that in small-scale experiments, crossings of P. nigra var. italica ♀ × P. lasiocarpa ♂ and of P. canadensis ♀ × P. aurifolia ♂ gave a good seed-set when the ♀ cut branches were kept 10 days in darkness at 5-9° C. before being brought into a light greenhouse for pollination.

———— 1961. NOVYE MEZVIDOVYE GIBRIDY TOPOLEJ. [NEW INTERSPECIFIC POPLAR HYBRIDS.] Bot. Z. 46(5): 710-8. 9 refs. [Russ.]

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A short account of experiments in the induction of polyploidy in P. tremula, and also in P. balsamifera, Euonymus europaeus and Quercus robur, with the aid of colchicine. [No conclusions or growth figures are given.] [Cf. Johnsson, 1953, P. tremula, 165.43]

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May, S. 1963. [THE APPARENT IMPROVEMENT OF POPLAR CLONES WITH GREY AND ROUGH BARK, AS AN EFFECT OF TOPOPHYSIS.] Cellulosa e Carta 14(10): 5-8. 6 refs. [It.it.f.e.g.]

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Braun, H., and Brendel, G. 1962. [EFFECTS OF PROVENANCE ON RESISTANCE TO DOTHICHIZA POPULEA AND BIOCHEMICAL DIFFERENCES DISTINGUISHING POPLAR SPECIES AND VARIETIES.] Naturwissenschaften 49(12): 286. 2 refs. [G.]

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Briefly describes investigations on length and distribution of stomata on poplar leaves, made at the Institut de Populiculture, Grammont, Belgium, and tabulates data for Populus tremula, P. tremuloides (and their crosses), P. grandidentata, P. nigra, P. deltoides and P. trichocarpa. The diagnostic value of this character is established.

Lee, C. B. 1955. THE IDENTIFICATION OF GENUS POPULUS IN KOREA BY WINTER TWIGS AND BUDS. Coll. Theseon (Sci. Nat.) Univ. Seoul No. 2: 75-80. 7 refs. [E.kor.]
A key, with descriptions and drawings, to eight species and two hybrids found in Korea.

Lesare. 1897. NOTES ON SOME VARIETIES OF POPLAR. Bull. Soc. For. Belg. 4: 40.

Makowiecki, A. 1930. DEUX PEUPLIERS INTERESSANTS. Roczn. Dendrol. Polsk. Tow Bot., Warsz., No. 3, p. 201. [Pol.]

Mathey. 1925. NOTES ON VARIOUS KINDS OF POPLAR IN FRANCE. Bull. Com. For., Paris No. 29, p. 451.

Mathiesen, A. 1953. UBER DIE ASPEN UND ANDERE POPULUSARTEN, WELCHE WILDWACHSEND IN DER PROVINZ ONTARIO VORKOMMEN. [ASPENS AND OTHER POPLAR SPECIES OCCURING WILD IN THE PROVINCE OF ONTARIO.] Zbl. Ges. Forst- u. Holzw. 72(1): 60-5. 5 refs. [G.]
A description of Populus tremuloides, P. grandidentata, P. balsamifera, and P. deltoides, their natural habitats, regeneration, diseases, associated species, and silvicultural treatment.

Meelker. 1930. POPLARS OCCURRING IN HOLLAND. Forstl. Rundschau 3: 477.

Meunier, G. 1947. LES PEUPLIERS FRANCAIS. [FRENCH POPLARS.] Les techniques du bois No. 4, 35 pp. [F.] Bblg. Editions de la Revue du Bois et de ses Applications, Paris.

Meyer-Uhlenried, K. -H. 1959. BIBLIOGRAPHIE DES INTERNATIONALEN PAPPELSCHRIFTTUMS. BAND 3, 1955-1958. [BIBLIOGRAPHY OF INTERNATIONAL LITERATURE ON POPLARS. VOL. 3, 1955-58.] Forstbotanisches Inst. Univ. Freiburg, Freiburg/Brag. 206 pp. [G.]
Mimeographed. Contains 1619 titles. [*Cf. Volkmann and Meyer-Uhlenried, 1954, this subject classification.*]

Morgeneyer [, W.] 1960. LANDFORSTMEISTER HERBERT GUNTHER. [HERBERT GUNTHER, CHIEF CONSERVATOR OF FORESTS DIED 28 MARCH 1960.] Arch. Forstw. 9(7): 665-9. 36 refs. [G.]
This obituary of the director of the Institut fur Forstwissenschaften, Tharandt, deals mainly with his pioneer work in poplars and willows. Of his publications here listed, 26 out of 36 obviously deal with poplars.

Morton. 1920. THE POPLAR TREES OF CANADA. Canad. For. Mag. 16: 573-5.

Musegjan, A. M. 1960. TOPOLJA KAZAHSTANA. [THE POPLARS OF KAZAKHSTAN.] Trud. Alma-Atinskogo Bot. Sada, Alma-Ata No. 5: 63-82. 13 refs. [Russ.]
Descriptions of the 11 introduced, and 15 naturally occurring, species of poplar in Kazakhstan.

Nakai, T. 1939. NOTULAE AD PLANTAS ASIAE ORIENTALIS. 8 & 9. [Notes on plants of Eastern Asia.] J. Jap. Bot. 15(7:9): 401-21; 523-41. Biol. Abstr. 15: 15314. 1941.

[Netherlands: Landbouwhogesch.] 1960. LIST OF POPLARS IN THE NURSERIES OF THE INSTITUTE OF FORESTRY RESEARCH, DIVISION OF SILVICULTURE OF THE AGRICULTURAL UNIVERSITY, WAGENINGEN. Landbouwhogeschool, Wageningen. 15 pp [E.Du.]

[Netherlands: Ned. Boschb.-Tijdschr.] 1960. DE POPULIER. [THE POPLAR.] Ned. Boschb.-Tijdschr. 32(5/6): 143-234. [Du.]

Peace, T. R. 1954. INTERNATIONAL CODE OF NOMENCLATURE FOR CULTIVATED PLANTS. Rep. 7th Sess. Int. Poplar Comm., Germany, pp. 39-42.

Piccarolo, G. 1951. LA PIOPPICULTURA NELLA VALLE PADANA. [POPLAR-GROWING IN THE PO VALLEY.] Ital. Agric. 88(6): 341-52. [It.]
Silvicultural methods and notes on genetics and taxonomy.

——— 1959. IL SERVIZIO DI RICONOSCIMENTO E DI CERTIFICAZIONE PER GARANZIA NELLA PIOPPICOLTURA INDUSTRIALE. [A SERVICE FOR IDENTIFICATION AND CERTIFICATION IN COMMERCIAL POPLAR GROWING.] Cellulosa e Carta 10(8): 5-14. [It.f.e.g.]
Surveys the existing difficulties and confusion in the field of poplar breeding in Italy in respect to the identification of species and nomenclature of clones, and gives a draft scheme for official regulation as requested by the International Poplar Commission.

Podhorski, I. 1951. UZGOJ TOPOLA. [POPLAR GROWING.] [Publ.] Inst. Sum. Istraz., Zagreb No. 6, 67 pp. 39 refs. [Croat.]

Polster, H., and Reichenbach, H. 1958. BESTIMMUNG VON BLATTFLACHEN IN SITU DURCH LINEARE MESSUNGEN. [THE DETERMINATION OF LEAF AREAS IN SITU BY LINEAR MEASUREMENTS.] Biol. Zbl. 77(3): 265-77. 17 refs. [G.g.]

Polycarpou, A. 1954. STATEMENT PREPARED FOR THE NEAR EAST POPLAR CONFERENCE, DAMASCUS, APRIL 1954. Cyprus For. Dep., Nicosia. 10 pp.
Covers statistical data, policy, silviculture, pests and diseases, logging and utilization.

Pourtet, J. 1950. DETERMINATION ET UTILISATION DES PEUPLIERS NOIRS CULTIVES EN FRANCE. [IDENTIFICATION AND USE OF THE BLACK POPLARS GROWN IN FRANCE.] Rev. For. Franc. 1950(2): 53-65. [F.]
Includes a key for identification, notes on silvicultural characters and uses, and recommendations for choice of species for different parts of France.

———— 1952. LES PEUPLIERS EN YOUGOSLAVIE. [POPLARS IN YUGOSLAVIA.] Rev. For. Franc. 1952(12): 819-26. [F.]
A brief account of the poplars occurring naturally, and cultivated, in Yugoslavia. The native species include two subspecies of P. alba, a hybrid of P. alba × P. tremula and P. nigra.

Quairiere, A. L. 1958. LE PEUPLIER EN BELGIQUE. [POPLARS IN BELGIUM.] Ann. Gembl. 64(1): 16-46. [F.]
A summary of information with special reference to Belgian conditions and covering classification, characteristics, choice of species, pests and diseases, methods of raising, tending of plantations, and costs and returns.

Rabouille. 1930. NOTE ON THE POPLAR IN FRANCE. Rev. Eaux For. 68: 534.

Ragonese, A. E., and Rial Alberti, F. 1959. RESENA SOBRE CULTIVO Y MEJORAMIENTO DE ALAMOS Y SAUCES EN LA REPUBLICA ARGENTINA. [REVIEW OF THE CULTIVATION AND IMPROVEMENT OF POPLARS AND WILLOWS IN ARGENTINA.] [Docum.] 10th Sess. Int. Poplar Comm. No. FAO/CIP/95L Add. 1, 27 pp. 84 refs. [Span.]
The review, which is amply documented, includes a survey of species and hybrids cultivated in Argentina, methods of raising and establishing willow plantations, probable yields, pests and diseases of both poplar and willow, and work achieved in breeding.

Rehder. 1931. NOTES ON NEW SPECIES OF POPULUS. J. Arnold Arbor. 12: 63.

———— and Kobuski. 1932. POPULUS SPP. OF NORTHWEST CHINA AND NORTHEAST TIBET. J. Arnold Arbor. 13: 385.

Rettelbach. 1956. BAYERN UND DIE PAPPEL. [THE POPLAR IN BAVARIA.] Holz-Zbl. 82(83): 1033-4. [G.]
A report on the Annual Conference of the German Poplar Society, including data on potential sites and actual plantings, a paper (followed by an excursion) on grey poplars in the Danubian bottom lands, (Krembs) describing the Ingolstadt grey poplar, a P. tremula × P. alba hybrid, site conditions, regeneration, diseases, etc.: also on afforestation with poplars and other spp. on waste land (dismantled munitions factory and rubble mounds).

Rojas Rojas, J. M. 1961. EL CHOPO EN GRANADA. [THE POPLAR IN GRANADA.] Montes, Madrid 17(99): 267-77.
A detailed general account, with volume and yield tables, and data upon which to base rotations for roundwood and sawtimber for clones of Populus × euroamericana (cv. "chopo negrito de Granada" and cv. "chopa de Granada") and Populus nigra (cv. "chopo castellano" or "blanquilla") as found in the R. Genil vicinity.

Rol, R. 1951. LES PEUPLIERS ET LES PRINCIPALES ESSENCES FORESTIERES DE L'EST DES ETATS-UNIS. RAPPORT DE MISSION MAI-JUIN 1950. [THE POPLARS AND THE PRINCIPAL FOREST TREE SPECIES OF THE EASTERN UNITED STATES. REPORT ON THE [O.E.E.C.]MISSION MAY-JUNE 1950.] Ann. Ec. Eaux For. Nancy 12(2): 527-637. 49 refs. [F.g.e.]
The main object of the mission was to study the poplars in their natural habitats, and the fast growing artificial hybrids made by American breeders; the latter are reported on unfavorably.

———— 1955. NOTE SUR LES PEUPLIERS DU CACHEMIRE. [NOTES ON THE POPLARS OF KASHMIR.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid, 1955. No. FAO/CIP/179-G, 3 pp. [F.]
Limited distribution. Tentatively identifies the following: Populus ciliata, P. longifolia, P. suaveolens, P. thevestina, and P. triloba, the last named large trees growing naturally at 2,500 m. alt. at the lower limit of the Himalaya cedar forest. All others are mostly young, their form spoilt by frequent lopping.

Rouleau, E. 1945. A NECESSARY TRANSFER IN POPULUS (TURENGA). Rhodora 47 (563): 362.

Sabeti, H. 1955. LE PEUPLIER EN IRAN. [THE POPLAR IN PERSIA.] Imp. Bank, Bazargani, Iran. 96 pp. [Pers.f.]
Describes the species grown in Persia (Populus euphratica, P. alba, P. hybrida M.B., P. nigra, P. nigra var. italica), their silvicultural characters, timber properties and uses, and lists insect pests and diseases. Photographs (78) have French legends.

Schenkenberg van Mierop, H. W. 1951. DE JAARKAP VAN POPULIEREN. [THE ANNUAL FELLINGS OF POPLAR.] Houthandel, Schiedam 3(50): 483-5. Abstr. in Ned. Boschb.-Tijdschr. 23(5): 158-9. 1951. [Du.]
Gives figures to show the volume of poplar and fellings in Holland during and since the war.

Schreiner, E. J. 1959. PRODUCTION OF POPLAR TIMBER IN EUROPE AND ITS SIGNIFICANCE AND APPLICATION IN THE UNITED STATES. Agric. Handb. U. S. Dep. Agric. No. 150, 124 pp
Describes in some detail species commonly grown, breeding and selection, nursery practice, site and soil requirements, planting, management, protection, growth and yield, and properties and utilization of wood.

———— and Stout, A. B. 1934. DESCRIPTION OF TEN NEW HYBRID POPLARS. Bull. Torrey Bot. Cl. 61: 449-60.

Schwerin. 1928. FEMALE FASTIGATE POPLARS. Mitt. Dtsch. Dendrol. Ges. 4: 327.

Sim. 1920. CULTIVATED TIMBER TREES (SOUTH AFRICA). S. Afr. J. Ind. 3: 782.

[Spain: Com. Nac. Chopo Madrid] 1957. MEMORIA 1957. [REPORT FOR 1957.] Mem. Com. Nac. Chopo, Madrid. 122 pp. 4 pp. of refs. [Span.]
A report in four parts: (1) Work of the Spanish National Poplar Commission in 1957, including 5-year plans of work and research, and a review of the present situation and possibilities for expansion in eight provinces, (2) projected work for 1958, (3) Spanish legislation governing the cultivation and exploitation of poplars, and (4) a list of Spanish publications on poplar up to the time of the report.

———— 1958. MEMORIA 1958. [REPORT FOR 1958.] Mem. Com. Nac. Chopo, Madrid. 163 pp. 4 refs. [Span.]
Reports on work achieved during 1958, the present situation, plans for 1959, and gives individual data on work in 22 provinces.

———— 1959. MEMORIA 1959. [REPORT [ON POPLARS] FOR 1959.] Mem. Com. Nac. Chopo, Madrid. 81 pp. [Span.]
Reviews the year's activities for 1959, and includes appendices giving the text of a report to the International Poplar Commission, reports on trial plots in three different provinces, results obtained with experimental clones in Leon Forest District, and the present situation and outlook in seven Spanish provinces.

Spalek, V. 1951. SYSTEMATIKA A SLECHTONI TOPOLU. [SYSTEMATICS AND BREEDING OF POPLARS.] Csl. Les 31(21): 466-70. [Cz.]

Stefanov, B., and Cikova, E. 1957. ZA CUZDOZEMNITE VIDOVE TOPOLI, OTGLEZDANI V BALGARIJA. [EXOTIC POPLAR SPECIES CULTIVATED IN BULGARIA.] Izv. Inst. Gorata Balg. Akad. Nauk., Sofia No. 2: 383-96. 11 refs. [Bulg.russ.g.]

Stegmann, G. 1959(1949). ANBAU UND VERWERTUNG DER PAPPEL IN WESTDEUTSCHLAND. [CULTIVATION AND UTILIZATION OF POPLARS IN WEST GERMANY.] Holz-Zbl. 85(145). [G.]
Summarizes papers read at a meeting of the utilization section of the German Poplar Commission on: Recent experience with poplars in the particle board and related industries (Klauditz); targets and limits of poplar growing in W. Germany (G. A. Schutze); high quality poplar pulp by the calcium-bisulphite process (T. Krause); the semichemical pulping of poplar and

willow grown outside the forest in Schleswig-Holstein [containing much reaction wood] (K. F. Patt); poplar assortments (Ulrich); and poplar yield studies (Volkmann).

Tabatabai, M. 1958. PAPELANBAU IN IRAN. [POPLAR CULTIVATION IN IRAN.] Silvae Genet. 7(6): 169-81. 45 refs. [G.g.e.f.]

Tronco, G. 1956. IL PIOPPO—QUESTO SCONOSCIUTO! [POPLAR—THE UNKNOWN.] Ital. Agric. 93(1): 63-86. [It.]
A general account of poplar breeding, silviculture and utilization in Italy. "White" Canadian poplar hybrids, particularly clone 488, are recommended for moist, fertile soils new to poplar growing, and black poplar hybrids (clones 154 and 214) for less fertile soils.

Turnbull, G. 1938. POPLARS. VARIETIES GROWN IN GREAT BRITAIN. J. Land Agents' Soc. 37(5): 243-45.

Uphof. 1922. POPLARS OF SOUTHWEST UNITED STATES. Mitt. Dtsch. Dendrol. Ges. 32: 172.

Vasil'ev, I. I. 1938. NOTES ON THE POPLARS OF THE FAR EASTERN REGION. Bull. Far East. Br. Acad. Sci. USSR 28(1): 101-07. [R.e.] Plant Sci. Lit. 7(26): 20.

Vicioso, O. 1951. SALICACEAE DE ESPANA. [SALICACEAE OF SPAIN.] [Bol.] Inst. For. Invest. Exp. Madrid 22(57), 131 pp. [Span.]
A botanical study of the Spanish Populus and Salix spp. with keys for their identification.

Vill, G. 1934. UBER PAPPELN. [ON POPLARS.] Dtsch. Forstw. 16: 153-7, 876-7 [G.]

Vinconneau, V. -R. 1949. LES PEUPLIERS DU POITOU ET DES CHARENTES ET LE CONGRES REGIONAL DU PEUPLIER A NIORT, (12-14 MAI 1948). [THE POPLARS OF THE POITOU-CHARENTE REGION AND THE REGIONAL POPLAR CONFERENCE AT NIORT, 12-14 MAY, 1948.] Rev. For. Franc. No. 2: 57-99. 19 refs. [F.]
Includes a short historical account and a description of the "Blanc du Poitou," a local variety of Populus serotina.

Volkmann, J. H. 1958. WELCHE HOLZERTRAGE SIND AUS DER STEIGERUNG DES PAPPELANBAUS IN WESTDEUTSCHLAND ZU ERWARTEN. [HOW MUCH WOOD MAY BE EXPECTED FROM THE INCREASE POPLAR GROWING IN WEST GERMANY?] Allg. Forstzeitschr. 13(38): 533-6. 12 refs. [G.]

——— and Meyer-Uhlenried, [K. -H.] 1954. BIBLIOGRAPHIE DES INTERNATIONALEN PAPPELSCHRIFTTUMS. [BIBLIOGRAPHY OF INTERNATIONAL LITERATURE ON POPLARS.] Nat. Pappelkommission, Kronprinzenstr. 15, Bonn. 202 pp. [G.]
In addition to the main list of 1,268 titles arranged according to the Oxford System of Decimal Classification, the work contains a concordance of the main heads of the system with the Flury System and four appendixes: (1) the bibliography from S. S. Pauley's "Forest tree genetics research: Populus L"; (2) subject index; (3) authors index; and (4) list of periodicals and serials cited, with abbreviations. Special efforts were made to cover the literature as completely as possible from 1951 on; references before that year are taken from the more comprehensive of recent works on poplars.

——— and Meyer-Uhlenried, [K. -H.] 1955. BIBLIOGRAPHIE DES INTERNATIONALEN PAPPELSCHRIFTTUMS. Band 2, 1954. [BIBLIOGRAPHY OF INTERNATIONAL LITERATURE ON POPLARS. VOL. 2, 1954.] Nat. Pappelkommission, Verwertungsausschuss, Braunschweig/Freiburg i. Br. 146 pp. [G.]
Contains 620 titles and a synopsis of Kollmann's classification of wood utilization and the Oxford System of Decimal Classification for Forestry.

Vucetic, J. S. 1958. O SAVREMENOJ NOMENKLATURI TOPOLA. [CONTEMPORARY POPLAR NOMENCLATURE.] Topola, Beograd No. 5: 333-56. 19 refs. [Serb.f.]
Describes recent activities of the FAO International Poplar Commission, and lists poplar species, varieties and hybrids under their scientific names, giving where it exists, the Yugoslav name, and occasionally also the French, German, or English name, with notes on distribution.

Vujic, P. 1958. TOPOLE U MADARSKOJ. [POPLARS IN HUNGARY.] Topola, Beograd No. 8: 680-6. 5 refs. [Serb.] [Cf. Joachim, 1958, this subject classification.]
Has short sections on: selection of planting material, methods of raising plantations, damage by pests and disease, and utilization of poplar wood.

Wettstein, W. von. 1952. DIE PAPPELKULTUR. [POPLAR CULTIVATION.] SchrReihe Ost. Ges. Holzforsch. No. 5, 52 pp. 22 refs [G.]
Contains chapters on: the economic importance of poplar; choice of site; cultivation; propagation; breeding; planting; description of species; and pests.

White, W. W. 1949(1951). NATIVE COTTOWOODS OF MONTANA. Proc. Mont. Acad. Sci., Missoula 9: 33-9. 8 refs.
Describes Populus acuminata, P. angustifolia, P. balsamifera, P. balsamifera candicans, P. sargentii, and P. trichocarpa hastata.

Woodward. 1933. NEW HYBRID POPLARS FOR REAFORESTATION IN NEW YORK. J. N. Y. Bot. Gdn. 34: 263-70.

Ye, P. C. 1955. [METHODS OF PROPAGATING [CHINESE] POPLARS.] For. Sci., Peking 1(1): 37-46. [Chin.]

Zabka, J. 1939. ON THE NOMENCLATURE OF THE POPLARS FROM THE TAXONOMICAL AND GENETICAL POINTS OF VIEW. Lesn. Prace 18(12): 586-91. Bblg. [Cz.g.]

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Bruckmann, J. J. 1954. OBSERVACIONES SOBRE EL RITMO VEGETATIVE ANUAL DE ALGUNOS ALAMOS EN EL DELTA DEL PARANA. [THE YEARLY GROWTH RHYTHM OF POPLARS IN THE PARANA DELTA.] Rev. Argent. Agron. 21(4): 215-30. [Span.]

Comte. 1927. THE POPLARS AND THEIR VALUE SILVICULTURALLY. J. For. Suisse 78: 179.

Fenaroli, L. 1953. NOTE SU L'ECOLOGIA E LA DISTRIBUZIONE DEI PIOPPI IN ITALIA. [NOTE ON THE ECOLOGY AND DISTRIBUTION OF [INDIGENOUS] POPLARS IN ITALY.] Suppl. to Ann. Sper. Agric. 7(2), 36 pp. [It.it.e.]
Gives distribution in Italy and ecological characters of 17 indigenous species, varieties, and hybrids, with numerous drawings to illustrate leaf morphology.

Feraroli, L. 1945. NOTE SULL'ECOLOGIA E DISTRIBUZIONE DEI PIOPPI IN ITALIA. [NOTES ON THE ECOLOGY AND DISTRIBUTION OF POPLARS IN ITALY.] Bosco, Feb. 1945: 2. [It.]

Guse. 1888. SILVICULTURAL IMPORTANCE AND DISTRIBUTION OF POPULUS IN RUSSIA. Allg. Forst- u. Jagdztg. 64: 439-443.

Houtzagers, G. 1937. THE GENUS POPULUS AND ITS SIGNIFICANCE IN SILVICULTURE. H. Veenman & Zonen, Wageningen. 366 pp. Bblg. [Du.e.]

Llensa de Gelcen, S. 1943. ESTUDIO BOTANICO-FORESTAL DE LOS CHOPOS (GENERE POPULUS). ENSAYO MONOGRAFICO SOBRE LOS CHOPERAS DE LA CUENCA INFERIOR DEL RIO TORDERA. [A SILVICULTURAL AND BOTANICAL STUDY OF POPULUS. PRELIMINARY MONOGRAPH ON THE POPLAR STANDS OF THE LOWER BASIN OF THE RIVER TORDERA.] Anales de la Escuela de Peritos Agricolas y Superior de Agricultura y de los Servicios Tecnicos de Agricultura, Barcelona 3(1/4): 131-295. 53 refs. [Span.]

Marcet, E. 1952. ZUM OKOLOGISCHEN VERHALTEN VERSCHIEDENER PAPPELSORTEN. [THE ECOLOGICAL BEHAVIOR OF SEVERAL KINDS OF POPLAR.] Schweiz. Z. Forstw. 103(11): 425-31. [G.]

Matyuk, I. S. 1940. THE GROWTH OF POPLARS UNDER THE CONDITIONS PREVAILING IN THE STEPPE. Lesn. Hoz. 1940(7): 41-4. Bblg. [Russ.]

Sibille. 1925. THE POPLAR. Bot. Abstr. 14: 1080.

Sudworth, G. B. 1934. POPLARS, PRINCIPAL TREE WILLOWS AND WALNUTS OF THE ROCKY MOUNTAIN REGION. Tech. Bull. U. S. Dep. Agric. No. 420, 112 pp.

Wroblewski, A. 1937. NAJSZYBCIEJ ROSNACE TOPOLE I ICH WZYTECZNOSC. [FAST-GROWING POPLARS AND THEIR USEFULNESS.] Roczn. Nauk Rol. 41: 330-7. Bblg. [Pol.f.]

181.1

Halliday, W. E. D., and Brown, A. W. A. 1943. THE DISTRIBUTION OF SOME IMPORTANT FOREST TREES IN CANADA. Ecology 24(3): 353-73. Bblg.

Legnier, R. 1956. DISTRIBUTION GEOGRAPHIQUE ET ORIGINE DES POPULUS. [GEOGRAPHICAL DISTRIBUTION AND ORIGIN OF POPLARS.] Proc. 8th Int. Bot. Cong., Sect. 3-6: 184-6. [F.]
Short notes on range and evolution.

181.21

Barner, J. 1954. EINE SELEKTIONSMOGLICHKEIT VERSCHIEDEN LICHTREAGIBLER PAPPELKLONE. [THE POSSIBILITY OF SELECTING POPLAR CLONES WITH DIFFERENT PHOTOTROPIC REACTION.] Abstr. in Z. Forstgenet. 3(6): 135. [G.]

Hoffmann, D. 1953. DIE ROLLE DES PHOTOPERIODIAMUS IN DER FORSTPFLANZENZUCHTUNG. [PHOTOPERIODISM IN TREE BREEDING.] Z. Forstgenet. 2(2): 44-7. [G.g.]

Perry, T. O. 1953. THE GENETICS OF THE PHOTOPERIODIC RESPONSE IN POPLAR TREE SPECIES. Abstr. in Genetics, Madison 38: 181-2. (1953 meeting, Genetics Soc. of Amer.)

Veen, R. van der. 1951. INFLUENCE OF DAYLENGTH ON THE DORMANCY OF SOME SPECIES OF THE GENUS POPULUS. Physiol. Plant., Copenhagen 4(1): 35-40. 2 refs. [E.]

181.22

Kostovcev, S. A. 1959. MOROZOSTOJKOST TOPOLEJ V USLOVIJAH MOSKOVSKOJ OBLASTI. [FROST-HARDINESS OF POPLARS IN THE MOSCOW REGION.] Lesn. Hoz. 12(6): 22-6. [Russ.]
A general account of trials with rooted cuttings. Some 60 species, hybrids and clones, are listed as being highly frost-hardy in the area.

181.3

Aichinger, E. 1957. DIE VEGETATIONSKARTIERUNG ALS GRUNDLAGE FUR DIE UBERFUHRUNG VON MINDERWERTIGEN ERLENAUWALDERN IN HOCHWERTIGE AUWIRTSCHAFTSWALDER. [SITE MAPPING AS A BASIS FOR THE CONVERSION OF BOTTOMLAND ALDERWOODLANDS OF LOW PRODUCTIVITY INTO HIGH-YIELDING PRODUCTION FORESTS.] Allg. Forstztg. 68(7/8): 91-2. 6 refs. [G.]

Giulimondi, G. 1959. INFLUENZA DI ALCUNE ANOMALIE STRUTTURALI DEL TERRENO SULL' ACCRESCIMENTO DEL PIOPPO IN VIVAIO. EFFECT OF SOME ANOMALIES OF SOIL STRUCTURE ON THE GROWTH OF POPLAR IN THE NURSERY.] Pubbl. Cent. Sper. Agric. For., Roma 2: 223-32. 9 refs. [It.it.e.e.]

Hilf, H. H. 1956. STANDORTSANSPRUCHE VON PAPPELSORTEN. [SITE REQUIREMENTS OF POPLAR VARIETIES.] Holzzucht, Reinbek 10(5): 7-8. 2 refs. [G.]
Chiefly a discussion of method, advocating a "clinical" approach to practical questions, which bases recommendations on practical experience as viewed in the light of fundamental research, in anticipation of scientifically established results. The author compares his own tentative scheme for allocating varieties to site types [cf. Hilf and Rohmeder, 1951, Populus sp., 232.1] with a revised scheme based on H. F. Joachim's classification [cf. Joachim, 1953, Populus sp., 181.36].

Jaro, B. 1960. ANYARAK TERMOHELYI IGENYE. [THE SITE DEMANDS OF POPLARS.] Erdo 9(1): 32-40. [Hu.russ.g.]
Since the climate of Hungary is generally suitable, the author considers the demands of different species of poplar on the physical, chemical, and hydrological properties of the soil. Limiting values of single factors are not critical. Recommendations for the heavier soils, classified by type and thickness of the fertile layer, are tabulated.

Marcet, E. 1960. MODELLVERSUCH ZUR FRAGE DER SPEZIFISCHEN EIGNUNG BESTIMMTER PAPPELSORTEN FUR NICHT OPTIMALE BODEN. PILOT TRIALS TO INVESTIGATE THE SPECIFIC ADAPTABILITY OF POPLAR VARIETIES TO INFERIOR SOILS.] Silvae Genet. 9(4): 93-101. 7 refs. [G.g.e.f.]

Raschke, G. 1959. PAPPELANBAU AUF GRENZSTANDORTEN? [GROWING POPLARS ON MARGINAL SITES.] Holzzucht, Reinbek 13 (3): 17-9. 9 refs. [G.]
Discusses German literature on experience with various species on sites with different unfavorable conditions, giving some data on the Reinbek trials with hybrid varieties. There, as elsewhere, the "Oxford" poplar had done very well on an originally rather heavy, acid poor soil, reaching 12 m. in height and 20 cm. d.b.h. at 7 years.

Schreiner, E. J. 1940. INHIBITING EFFECT OF SOD ON THE GROWTH OF HYBRID POPLAR. U. S. Forest Serv. Ntheast. For. Exp. Sta. Occ. Pap. No. 8, 11 pp.

———— 1945. HOW SOD AFFECTS ESTABLISHMENT OF HYBRID POPLAR PLANTATIONS. J. For. 43(6): 412-27. Bblg.

181.31

Krolikowski, L., and Strzelec, Z. 1961. [GROWTH OF ALNUS GLUTINOSA, A. INCANA, POPULUS TREMULA AND P. × BEROLINENSIS WITH DIFFERENT GROUND-WATER LEVELS IN SANDY SOILS.] Roczn. Gleboznawcze, Warsz. 10 (Suppl.): 724-5 [Pol.]
After 3 years, with groundwater at ca. 70 cm. A. glutinosa did best, then P. × berolinensis and A. incana; with groundwater at ca. 130 cm., A. incana did best, then P. × berolinensis and A. glutinosa.

181.311

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Chief reliance should be placed on American species successful in Italy and also Populus nigra var. italica. Two places, one in the valley of the Meric (e.g. Kurtbucagi forest) and the other near Adrianople, are recommended, but would need water in summer. No other places appear suitable.

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The work carried out by the Research Branch of the British Forestry Commission since 1948 has suggested that there are special features in the design of poplar experiments that do not appear to be adequately described in published literature. It is the purpose of this record to make available the conclusions reached during the past 10 years.

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A report summarizing replies to a questionnaire [cf. International: FAO/Int. Poplar Comm., 1955 and 1956, Populus sp., 232.11/13], and discussing recommendations of a Working Party of I.U.F.R.O., with an annexe giving a system of symbols (letters and figures) to designate the nature, nursery treatment, and age of poplar plants, proposed by E. Allegri.

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Sirjaeva, V. M. 1960. OSOBENNOSTI ROSTA NEKOTORYH DREVESNYH PORODV USLOVIJAH SREDNEGO TECENIJA AMU-DAR I I IH ROL V SOZDANII IRRIGACIONNYH LESONASAZDENIJ. [FEATURES OF THE GROWTH OF SOME WOODY SPECIES IN THE CENTRAL PART OF THE AMU-DARYA VALLEY, AND THEIR IMPORTANCE IN THE CREATION OF IRRIGATED STANDS.] Lesn. Z. Arhangel'sk 3(1): 49-53. 4 refs. [Russ.]

Somogyi, Z. 1958. GYORSAN NOVO FAFAJOK AZ ORMANSAGON. [FAST GROWING SPECIES IN THE ORMANSAG DISTRICT.] Erdo 7(11): 428-33. [Hu.hu.russ.g.]
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Szigethy, B. 1959. GYORSAN NOVO FAFAJOK TELEPITESENAK LEHETOSEGEI A KELETBUKKI ERDOGAZDASAG TERULETEN. [POSSIBILITIES OF PLANTING FAST-GROWING WOODY SPECIES IN THE KELET-BUKK FOREST REGION.] Erdo 8(8): 308-11. [Hu.russ.g.]

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Contains tabulated statistics of area and yield by species and their values. Ca. 1/3 of the forest area is suitable for poplars, which provide the greatest volume and value yields, amenable also to augmentation. Improvements in willow cultivation lie in breeding, and the abolition of the coppice system, and timely tending. Oaks, if planted, should be mixed with poplars; game control is an important prerequisite.

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Wettstein-Westerheim. 1934. WELCHE PAPPELN KONNEN ZUR FORSTLICHEN PFLANZUNG EMPFOHLEN WERDEN? [WHAT POPLARS CAN BE RECOMMENDED FOR FOREST PLANTING?] Forstarchiv 10: 97-101. [G.]

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[Argentina: Adm. Nac. Bosques, B. Aires] 1955. CULTIVO DE LOS ALAMOS. [THE CULTIVATION OF POPLARS.] Hoja Divulg. Adm. Nac. Bosques, B. Aires No. 6, 3 pp. [Span.]
Short notes on the performance of Populus spp. in Argentina, their silvicultural requirements and methods of establishing plantations.

Chardenon, J. 1954. LES PEUPLIERS AMERICAINS D'IMPORTATION RECENTE. [AMERICAN POPLARS RECENTLY IMPORTED [INTO FRANCE].] [Pap.] 8th Int. Bot. Congr. Paris Sect. 13: 144-5. [F.]

———— 1955. RECENTES INTRODUCTIONS DE PEUPLIERS DES ETATS - UNIS EN FRANCE. [POPLARS RECENTLY INTRODUCED FROM THE U.S.A. TO FRANCE.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/19-H, 2 pp. [F.]
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Fernandez, A. E. 1960. OBSERVACIONES SOBRE CRECIMIENTO DE ALAMOS EN LA ESTACION FORESTAL DEL PARANA MINI. [GROWTH OF POPLARS AT THE PARANA MINI FORESTRY CENTRE.] Foll. Tec. For. Adm. Nac. Bosques, B. Aires No. 10, 11 pp. [Span.span.]

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Matveev, P. N. 1960. RAZVEDENIE TOPOLEJ V TUGAJAH. [CULTIVATING POPLARS IN [CENTRAL ASIAN] RIPARIAN WOODLANDS.] Lesn. Hoz. 12(9): 42-4. [Russ.]

Neumann. 1956. BEMERKUNGEN UBER EINIGE PAPPELARTEN. [NOTES ON SOME POPLAR VARIETIES.] Forst- u. Holzw. 11(16): 345-6. [G.]
Summarizes an article of that title, by a Herr Walter, in the "Forst- und Jagdarchiv von und fur Preussen," May 1817, mentioning experience with Populus deltoides, P. canescens, balsam poplar and Lombardy poplar, in Prussia over 100 years ago.

Salins, S., and Smilga, J. 1960. PETIJUMI PAR DAZAM PAPELU SUGAM KOKAUDZETAVA. [NURSERY INVESTIGATIONS ON SOME POPLARS.] Trud. Inst. Lesohoz. Probl., Riga No. 20: 55-69. 15 refs. [Latv. russ.]

Soromaa, O. 1956. ALGUNOS DATOS SOBRE EL DESARRELLO DEL ALAMO EN FORMACION EN LES BOSQUES DE LAS ZONAS DE RENGO Y PARRAL. [DATA ON THE DEVELOPMENT OF POPLAR STANDS IN THE RENGO AND PARRAL REGIONS.] Chile Maderero 6(2): 11-4. [Span.]
The poplar plantations of Rengo and Parral were established for the match industry. Notes are presented on climate and soils, with data on increment and yield of normal stands.

Toth, B. 1960. NYARFATERMELESI TANULSAGOK A PUSPOKLADANYI SZIKKISERLETI TELEPEN. [EXPERIENCE IN GROWING POPLARS AT THE "SZIK" SOILS EXPERIMENT STATION, PUSPOKLADANY.] Erdo 9(2): 49-59. [Hu.russ.g.]
Gives soil properties and growth-data tables. A relatively high pulpwood production is possible in 10-15 years on these soils, and poplar is considered a better economic proposition than the pedunculate oak hitherto favored. As, however, this can be proved only by long and difficult trials, an initial mixture of oak and poplar is advised.

232.11/13

Gunzl, L. 1954. ERGEBNISSE DER OSTERREICHISCHEN PAPPELSORTENPRUFUNG 1949-52. [RESULTS OF POPLAR VARIETY TESTS IN AUSTRIA, 1949-52.] Allg. Forstztg. 65(9/10): 125-31. 11 refs. [G.g.]

[International: FAO/Int. Poplar Comm.] 1955 and 1956. STATISTICAL METHODS IN EXPERIMENTS. [QUESTIONNAIRE CONCERNING MEASUREMENTS AND OBSERVATIONS IN POPLAR EXPERIMENTS AND REPLIES FROM SWITZERLAND, UNITED KINGDOM, BELGIUM, SPAIN, U.S.A., AUSTRIA, SWEDEN, AND FRANCE.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/CP/77, 1955. 8 pp. [Pap.] 12th Sess. Stand. Exec. Comm. Int. Poplar Comm., Brussels 1956 Nos. FAO/CIP/CP/7-A to -H, 1956. Each 3 pp. [E. or F.]

———— 1956. STATISTICAL METHODS IN EXPERIMENTS. MEASUREMENTS AND OBSERVATIONS IN POPLAR EXPERIMENTS. GERMANY. [Docum.] 12th Sess. Stand. Exec. Comm. Int. Poplar Comm., Brussels 1956 No. FAO/CIP/CP/7-L-a,b&c. Each 2 pp. [E.]
Three answers to questionnaire FAO/CIP/77.

———— 1956. STATISTICAL METHODS IN EXPERIMENTS. MEASUREMENTS AND OBSERVATIONS IN POPLAR EXPERIMENTS. REPLIES TO QUESTIONNAIRE OF DOCUMENT FAO CIP/77. EGYPT. IRAQ. [Docum.] 12th Sess. Stand. Exec. Comm. Int. Poplar Comm., Brussels 1956 No. FAO/CIP/7-I, 3 pp., and No. FAO/CIP/7-J, 7 pp. [E.]

———— 1956. METHODES EMPLOYEES DANS LES EXPERIENCES EN COURS. MESURES ET OBSERVATIONS DANS LES ESSAIS DE PEUPLIER. REPONSES AU QUESTIONNAIRE DU DOCUMENT FAO/CIP/77. IRAN. [STATISTICAL METHODS IN EXPERIMENTS. MEASUREMENTS AND OBSERVATIONS IN POPLAR EXPERIMENTS. REPLIES TO QUESTIONNAIRE FAO/CIP/77. IRAN.] [Docum.] 12th Sess. Stand. Exec. Comm. Int. Poplar Comm., Brussels 1956. 3 pp. [F.]

Jayme, G., and Harders-Steinhauser, M. 1963. [COMPARATIVE RESULTS FROM A POPLAR CULTIVATION STUDY IN 1943-61.] Papier, Darmstadt 17(7): 298-306. [G.g.e.f.]

Jobling, J. 1957. STATISTICAL METHODS IN EXPERIMENTS. A REPORT PREPARED BY MR. J. JOBLING, ASSISTANT SILVICULTURIST, ON THE BASIS OF THE QUESTIONNAIRES COMPLETED BY THE NATIONAL POPLAR COMMISSION. [Docum.] 13th Sess. Stand. Exec. Comm. Int. Poplar Comm., Paris 1957 No. FAO/CIP/CP/11, 16 pp. [E.]

———— 1960. POPLARS AND ELMS. Extr. from Rep. For. Res. For. Comm., Lond. 1958/59: 54-8.

Levasev, B. G. 1963. [PLANTATIONS OF NEW POPLARS IN BASHKIRIA.] Lesn. Hoz. 16(4): 35-40. [Russ.]

Szeless, S. 1954. VERSUCHE MIT PAPPELN IM OBEREN MURZTAL. [POPLAR TRIALS IN THE UPPER MURZ VALLEY.] Allg. Forstztg. 65 (1/2): 8-9. [G.]

Templin, E. 1956. MOGLICHKEITEN EINER INTERNATIONALEN ZUSAMMENARBEIT BEI DER PRUFUNG WIDERSTANDSFAHIGER PAPPELKLONE GEGEN TIERISCHEN SCHADLINGSBEFALL. [POSSIBILITIES OF INTERNATIONAL CO-OPERATION IN TESTING POPLAR CLONES RESISTANT TO INSECT PESTS.] [Docum.] 12th Congr. Int. Union For. Res. Organ., Oxford 1956 No. IUFRO/56/24/17, 4 pp. [G.]

Zarhina, E. S. 1963. [TESTING POPLAR VARIETIES IN THE AMUR REGION.] Lesn. Hoz. 16(3): 21-4. [Russ.]
Gives preliminary results of 2-3 years' nursery and field testing of many poplar varieties and hybrids.

Baldwin, H. I. 1941. GROWTH OF HYBRID POPLARS. Fox For. Notes No. 26, 1 p.

Bezkorovajnyj, M. F. 1958. GIBRIDNYE TOPOLI V LENINGRADSKOJ OBLASTI. [HYBRID POPLARS IN THE LENINGRAD AREA.] Lesn. Hoz. 11(3): 82. [Russ.]
A brief note on trials with cuttings of 10 hybrid poplars, giving percent take, height at 1 year, and at 2 years (after a severe winter in which temperatures reached —34° C. in December, January, and February), when heights ranged from 1.3 to 2.4 m.

Blow, F. E. 1948. HYBRID POPLAR PERFORMANCE IN TESTS IN THE TENNESSEE VALLEY. J. For. 46(7): 493-9. 14 refs.

Cram, W. H. 1960. PERFORMANCE OF SEVENTEEN POPLAR CLONES IN SOUTH CENTRAL SASKATCHEWAN. For. Chron. 36(3): 204-8, 224. 14 refs.

Dalal, S. S., Patnaik, N., and Singh, B. 1962. PRELIMINARY TRIALS ON POPLARS. Indian For. 88(8): 552-9. 3 refs.
Preliminary results of trials of 15 poplar clones in the Dun Valley, Dehra Dun. It is concluded that conditions are very favorable to poplar growth. By far the most successful clone was Populus "Casale 488," with "Casale 30" close behind. Moderately good were "Heidemij I.J. 116," "Robusta A E," P. nigra var. italica "F," "Rubra boiret," "Eugenii U.L.," "Eugenii B" and "Regenerata carpieri."

Doolittle, W. T. 1953. GROWTH AND SURVIVAL OF HYBRID POPLARS. Sth. Lumberm. 187(2345): 178-9.

Elorrieta Artaza, J., and Alarcon Marticorena, F. 1957. SECCION DE REPOBLACIONES E INTRODUCCION DE ESPECIES. [SECTION FOR AFFORESTATION AND INTRODUCTION OF SPECIES.] An. Inst. For. Invest. Exp., Madrid No. 2: 41-7. [Span.]
Reports on the previous year's trials of poplar hybrids and clones.

Funk, D. T. 1963. HYBRID POPLARS ON OHIO SPOIL BANKS. U. S. For. Serv. Cent. St. For. Exp. Sta. Res. Note No. CS-8, 4 pp. 7 refs. Columbus, Ohio.
Describes trials begun in 1951 with 50 hybrid clones on strip-mined areas with sparse vegetation, showing that such cultivation is possible on the more permeable and better aerated banks, and summarizes results with particular clones.

Gysel, L. W. 1949. THE SURVIVAL AND GROWTH OF HYBRID POPLARS IN FOUR MICHIGAN TEST AREAS. Quart. Bull. Mich. Agric. Exp. Sta. 32(1): 156-65.

Hara, M., and Tanaka, K. 1955. [ON THE GROWTH OF CUTTINGS OF POPLARS [OBTAINED] BY CROSSING IN U.S.A.] Trans. Tottori Soc. Agric. Sci., Tottori 10(4): 30-3. 3 refs. [Jap.e.e.]

[International: FAO/Int. Poplar Comm.] 1953. DIRECTIONS FOR THE SURVEY OF POPLAR AREAL PLOTS BY THE NATIONAL POPLAR COMMISSION OF THE NETHERLANDS. [Pap.] 7th Sess. Int. Poplar Comm. No. FAO/53/8/6312, 10 pp.
Directions for (1) methods of measurement, (2) design of experimental plots, in research on poplar clones.

Janson, L. 1960. WZROST ROZNYCH FORM TOPOLI W CZTEROLETNIEJ UPRAWIE PROWADZONEJ EKSTENSYWNIE. [GROWTH OF VARIOUS

FORMS OF POPLAR IN FOUR-YEAR-OLD PLANTATIONS RUN ON EXTENSIVE LINES.] Sylwan 104(7): 79-86. [Pol.] (Biul. Inst. Bad. Lesn. No. 3. 1960.)

Konovalov, N. A. 1963. [SELECTION AND BREEDING OF FAST-GROWING TREE SPECIES IN THE CENTRAL URALS.] Lesn. Hoz. 16(7): 55-8. [Russ.]

Newcomer, E. H. 1946. A THREE-YEAR TRIAL OF HYBRID POPLARS IN NORTH CAROLINA. J. Elisha Mitchell Sci. Soc. 62(1): 77-80. Bblg.

Rader-Roitzsch, J. E. 1956. DER PAPPEL-PROBEANBAU VOM JAHRE 1951 IN SUDDEUTSCHLAND. [POPLAR TRIALS OF 1951 IN SOUTHERN GERMANY.] Schweiz. Z. Forstw. 107(8/9): 444-57. 8 refs. [G.f.]
Discusses results, and tabulates mean values, of mortality, height and diameter growth, and injuries, from 150 trials covering the first 3 growing seasons of the following: Populus regenerata, P. bachelieri, P. vernirubens, P. serotina, P. "canadensis" Leipzig, P. marilandica, P. robusta I., P. robusta II (Isarpappel) and P. gelrica planted as 1- or 2-year-old stock.

Rubbo, R. 1957. LOS ALAMOS HIBRIDOS EN EL URUGUAY. [HYBRID POPLARS IN URUGUAY.] Montes, Madrid 13(73): 16-8. [Span.]
Notes on the introduction of hybrid poplars into Uruguay, with an estimate of the susceptibility or resistance to Melampsora spp. and Septoria spp. of six different clones, and recommends the founding of a Poplar Institute in Uruguay on the lines of the one at Casale Monferrato in Italy.

Rudolf, P. O. 1948. HYBRID POPLAR PLANTING IN THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 14, 17 pp. 6 refs.

Santamour, F. S., Jr. 1960. THE RELATION BETWEEN ANATOMY AND INHERENT GROWTH POTENTIAL OF HYBRID POPLARS. Abstr. of thesis, in Dissert. Abstr. 21(4): 718. [Univ. Minn.]

Sebald, O. 1959. ERGEBNISSE VON PAPPELSORTEN-VERGLEICHSVERSUCHEN. I. ERSTE AUSWERTUNG DER 1948 BIS 1953 IN NORDWURTTEMBERG ANGELEGTEN BEOBACHTUNGSFLACHEN. [TRIALS OF POPLAR VARIETIES. I. FIRST RESULTS OF OBSERVATION PLOTS ESTABLISHED IN N. WURTTEMBERG FROM 1948 TO 1953.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 8: 3-34. 33 refs. [G.g.]

Silen, R. R. 1947. COMPARATIVE GROWTH OF HYBRID POPLARS AND NATIVE NORTHERN BLACK COTTONWOODS. U. S. For. Serv. Pacif. Nthwest. For. Exp. Sta. For. Res. Notes No. 35, 3 pp.

Stecki, Z. 1963. [INVESTIGATIONS ON GROWTH OF POPLAR HYBRIDS WITH REFERENCE TO SELECTION.] Arboretum Kornickie, Poznan 8: 155-218. 47 refs. [Pol.russ.e.e.]

Trimble, G. R., Jr. 1963. HYBRID POPLAR GROWS POORLY ON ACID SPOIL BANKS AT HIGH ELEVATIONS IN WEST VIRGINIA. U. S. For. Serv. Res. Note NE-7, 4 pp. Ntheast. For. Exp. Sta., Upper Darby, Pa.

[U.S.S.R.: Akad. Nauk Kazah. SSR] 1962. DREVESNAJA RASTITEL NOST ALMA-ATINSKOGO BOTANICESKOGO SADA. [THE WOODY PLANTS OF THE ALMA-ATA BOTANICAL GARDEN.] Izdatel stvo Akademii Nauk Kazahskoj SSR, Alma-Ata. 329 pp. 66 refs. [Russ.]

232.3

Richter. 1929. SEEDING FROM P. ALBA, TREMULA AND CANADENSIS. Silva 17: 258.

Thaler. 1906. CULTIVATION OF POPLARS AND SORBUS FROM SEED. F. & J. Zeitung 82: 117.

———— 1908. CULTIVATION OF POPLAR FROM SEED. F. & J. Zeitung 84: 378.

Vonhausen. 1879. NOTE ON CULTIVATION OF ITALIAN POPULUS FROM SEED. Allg. Forst- u. Jagdztg. 55: 261-2.

———— 1881. CULTIVATION OF ITALIAN POPLAR FROM SEED. Allg. Forst- u. Jagdztg. 57: 297-302.

232.31

Moss, E. H. 1938. LONGEVITY OF SEED AND ESTABLISHMENT OF SEEDLINGS IN SPECIES OF POPULUS. Bot. Gaz. 99(3): 529-542. Biol. Abstr. 12(4): 7056. 1938.

Richter. 1934. UBER PAPPELSAATEN. [ON POPLAR SEED.] Forstl. Wochenschr. Silva 22: 321-22. [G.]

Richter, H. 1936. ON POPLAR SEED. Forstwiss. Cbl. 58(24): 813-18. [G.]

232.311.2

Babos, I. 1959(1960). MAGTERMELO AKACOSOK ES NYARFASOK VIZSGALATA. [SEED-PRODUCING STANDS OF ROBINIA AND POPLARS.] Erdesz. Kutatas., Budapest 6(3): 15-65. 22 refs. [Hu.russ.g.e. *russ.g.e.*]

232.312

Roe, E. I., and McCain, D. P. 1962. A QUICK METHOD OF COLLECTING AND CLEANING ASPEN SEED. U. S. For. Serv. Tree Plant. Notes No. 51: 17-8.
Branches of Populus grandidentata and P. tremuloides bearing near-mature catkins are brought into a warm, closed room with little air movement. When the catkins begin to open, the seed is collected with an upholstery-type vacuum cleaner; the mass of cotton is then removed from the cleaner bag, placed between screens, and the seed extracted by the use of compressed air.

232.312.2

Einspahr, D., and Schlafke, D. 1957. A METHOD FOR ASPEN AND COTTONWOOD SEED EXTRACTION. U. S. For. Serv. Tree Plant. Notes No. 28: 10.
Describes a simple method, involving the use of a piece of cardboard tubing, three superimposed sieves, and a compressed-air line (illustrated).

Marjai, Z. 1959. A NYARMAG GEPI SZIKKASZTASA. [THE MECHANICAL DRYING OF POPLAR SEED.] Erdo 8(3): 94-7. [Hu.russ.g.]
It was found that keeping improved and germination was relatively higher (70-80%) if moisture content of seed was held at 5-8%. After a pilot trial with a hair-drier playing through a drum, a larger scale operation showed that a fan blowing through a cylinder 20 cm. long x 50 cm. wide could dry 10 kg. of seed in 8 hours.

232.315

Johnson, L. P. V. 1946. EFFECT OF HUMIDITY ON THE LONGEVITY OF POPULUS AND ULMUS SEEDS IN STORAGE. Canad. J. Res. 24th (6): 298-302. Bblg.

232.315.2

Kopeczky, F. 1954. A NYARMAGVAK CSIRAZASELETTANI VIZSGALATA. [INVESTIGATIONS ON THE PHYSIOLOGY OF GERMINATION OF POPLAR SEEDS.] Erdesz. Kutatas., Budapest 1954(1): 6-17. [Hu.] From abstr. in Hung. Agric. Rev. 3(2): 8. 1954. [E.]
Poplar seed [species not named] stored in a desiccator (with $CaCl_2$) placed in an ice-box at 0.5°C., showed only slight decrease of germinative capacity from the initial 98 to 94% after 5 months.

Sato, Y. 1949. ON THE VIABILITY OF POPULUS SEEDS. Res. Bull. Exp. For. Hokkaido Univ. 14(2): 77-92. 22 refs. [Jap.jap.o.]

232.318

Tucovic, A. 1955. NEKA ZAPASANJA O KLIJAVOSTI SEMENA TOPOLA. [THE GERMINATION OF POPLAR SEEDS.] Glasn. Sum. Fak., Beograd No. 9: 167-77. 6 refs. [Serb.g.]
Compares the germinative energy and germination percent of seed of 10 poplar species, collected from and around Belgrade.

232.32

Bocke. 1924. NOTE ON THE RAISING OF POPLARS. Dtsch. Forstztg. 39: 1114.

Geyda, K. 1948. O TOPOLI I JEJ ROZMNAZANIU. [POPLARS AND THEIR PROPAGATION.] Wydaw. Pomocn. Tech. -Gosp. Inst. Bad. Lesn. No. 17, 84 pp. 15 refs. [Pol.]

Gunther, H. 1958. DEZENTRALISIERUNG ODER ZENTRALISIERUNG DER ERZIEHUNG VON PAPPELPFLANZEN? [CENTRALIZATION OR DECENTRALIZATION IN THE RAISING OF POPLAR PLANTS?] Forst u. Jagd 8(4): 156-8. [G.]
Advocates large centralized nurseries, as seen on a study tour in Hungary, because large nurseries devoted to poplar growing

would be able to obtain expert personnel, and their management, control, and mechanization would be easier than that of small, decentralized ones.

Hoffmann, R. 1936. RAISING POPLARS FROM SEED. Forstwiss. Cbl. 58(1): 28-34. [G.]

Houtzagers, G. 1941. HET KWEEKEN VAN POPULIERENHEESTERS. [THE RAISING OF POPLAR PLANTING STOCK.] Ned. Boschb.-Tijdschr. 14(3): 114-7. [Du.]

[Jugoslavia: Gozd Vestn.] 1954 RAZMNOZEVANJE TOPOLOV (BELEGA, CRNEGA, SIVEGA IN TREPETLIKE) S SEMENI. [PROPAGATION OF POPLARS (POPULUS ALBA, P. NIGRA, P. CANESCENS AND P. TREMULA) FROM SEED.] Gozd. Vestn. 12(4): 118-9. [Sloven.]

Kopecky, F. 1961. ERDOGAZDASAGAINK NYAR ES FEHERFUZ TORZSANYATELEPEINEK ALLAPOTA. [CONDITION OF THE POPLAR AND WILLOW NURSERIES IN HUNGARY.] Erdo 10(7): 288-92. [Hu.russ.g.]
It is proposed to reduce the % of P. × serotina (26) in favor of P. × robusta (21) in the 166 ha. of nurseries concerned and raise also the proportion of new clones under test. Trials of 100 × 100 cm. spacing produced too large material in the first 2-3 years and thereafter perfect material for 6-7 years. With smaller spacing the nursery soil gets exhausted in 5-6 years. Insect damage has greatly increased in several nurseries.

Liese. 1933. PRODUCTION OF HEALTHY ASPEN AND POPLAR PLANTS. Forstarchiv 9: 109.

Lucke, H. 1951. PAPPEL- PFLANZENZUCHT UND -ANBAU. [POPLAR PROPAGATION AND THE ESTABLISHMENT OF POPLAR PLANTATIONS.] M. & H. Schaper, Hannover. 54 pp. 21 refs. [G.]
A practical guide to nursery work (propagation by seed, root suckers, and cuttings; tending; and diseases and pests of nursery stock) and planting (choice of site and variety, planting methods, spacing, and early tending) with chief reference to the hybrid black poplars.

Osaja, D. 1948. NYARCSEMETEK NEVELESE. [THE RAISING OF POPLARS FROM SEED.] Erdesz. Lapok. 84(2/3): 100-4. [Hu.g.f.e.]

Ournay. 1896. PROPAGATION METHODS FOR THE POPLAR. Bull. Soc. For. Belg. 3: 793.

Pavlenko, F. A., and Starova, N. V. 1958. VYRASCIVANIE SEJANCEV TOPOLEJ NA UKRAINE. [GROWING POPLAR SEEDLINGS IN THE UKRAINE.] Lesn. Hoz. 11(4): 22-6. [Russ.]

Walter. 1957. KOMBINATION DES PAPPELANBAUS MIT LANDWIRTSCHAFTLICHER ZWISCHENNUTZUNG. [A COMBINATION OF POPLAR GROWING WITH AGRICULTURAL INTERCROPPING.] Forst u. Jagd Spec. No. Die Pappel 2: 14-5. [G.]

Wettstein, W. 1958. STAND DER PAPPELANZUCHT IN OSTERREICH IM JAHRE 1957. [POPLAR RAISING IN AUSTRIA IN 1957.] Holz-Kurier 13(1): 10-2. [G.]
Data on the number of 1 + 1, 1 + 2, etc., plants produced and/or available for sale, with a note on changes in nomenclature of some cultivars.

232.322.1

Gunther, H., and Morgeneyer, W. 1956. LUPINENVORANBAU IN PAPPELMUTTERGARTEN. [SOIL PREPARATION WITH LUPINS IN POPLAR STOOL-BEDS.] Forst u. Jagd 6(4): 180-2. [G.]

232.322.4

Giardini, A. 1963. RICERCHE SPERIMENTALI SULLA CONCIMAZIONE DEL PIOPPO. [EXPERIMENTAL RESEARCH ON THE FERTILIZING OF POPLAR.] Centro Incremento Fertilizzazioni, Consulta per l'Agricoltura e le Foreeste delle Venezie, Venice. 123 pp. [It.]
Gives an account of the experiments and preliminary results of the first 4 years, on representative soils of Venetia. Subjects of research are nutrition of poplar, the use of compound fertilizers, and methods of application.

Gunther, H. 1956. UNTERSUCHUNGEN UBER DIE VERWENDUNG VON PAPPELSTECKLINGEN ZUR KIPPENKULTIVIERUNG IN DER NIEDERLAUSITZ. [THE USE OF POPLAR CUTTINGS FOR THE REVEGETATION OF SPOILMOUNDS IN THE NIEDERLAUSITZ.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 16 (Beitr. Pappelforsch. No. 1): 51-70. 6 refs. [G.g.]

Morani, V. 1961. RICERCHE SULLA CONCIMAZIONE DEL PIOPPO. [RESEARCH ON THE FERTILIZING OF POPLAR.] Cellulosa e Carta 12(10): 8-12. 25 refs. [It.f.e.g.]
Reviews the results of research (mainly in England, France, and Italy) during the past 10 years on the application of fertilizers to poplars in the nursery and in the field.

232.322.41

Gunther, H. 1957. DIE VERWENDUNG VON "GLUCKAUF"—VOLLDUNGER ZUR ERZIEHUNG VON PAPPELPFLANZEN. [THE USE OF THE "GLUCKAUF" COMPLETE FERTILIZER IN GROWING YOUNG POPLARS.] Forst u. Jagd Spec. No. Die Pappel 2: 12-5. [G.]
When this fertilizer, containing 10% N, 7% P_2O_5, 20% K_2O, 17% $MgSO_4$, 10% CaO plus trace elements, was tried on 1-year poplar plants on a rather poor, neutral sandy loam at 300, 600, and 900 kg./ha., second-year height growth exceeded controls by 36, 69.9, and 81.9% respectively.

232.322.411

Giulimondi, G. 1961. EFFETTI DELLA CONCIMAZIONE AZOTATA SU PIOPELLE IN VIVAIO. [THE EFFECTS OF N FERTILIZING ON YOUNG POPLARS IN THE NURSERY.] Cellulosa e Carta 12(5): 27-30. 6 refs. [It.f.e.g.]
Presents and discusses data from experiments at Rome in which nursery beds were fertilized with $(NH_4)_2SO_4$ at rates of 400 and 800 kg./ha.; mean height and mean d.b.h. increased with increasing applications of N, but mean d.b.h. of height classes diminished; moisture content increased and specific gravity decreased. Measurements were made 9 months after the rooted cuttings were planted.

232.322.412

[Netherlands: T.N.O.] 1957. [APPLICATION OF FERTILIZERS TO POPLARS.] Korte Meded. Bosbouwproefsta., T.N.O., Wageningen No. 30: 13-4. [Du.]
A number of field trials have been laid out. In greenhouse tests, root and top growth of cuttings of Populus robusta were greatly improved by addition of basic slag to the soil. Superphosphate reduced growth, probably because of acidity, excessive salt concentrations or both.

Schonnamsgruber, H. 1956. DUNGUNGSVERSUCHE MIT PHOSPHAT BEI PAPPELJUNGPFLANZEN. [FERTILIZER TRIALS WITH PHOSPHATES ON YOUNG POPLAR PLANTS.] Phosphorsaure, Essen 16 (1/2): 56-68. 5 refs. [G.g.]

232.323

Bakkay, L. 1954. NYAR MAGCSEMETENEVELES. [THE RAISING OF POPLAR SEEDLINGS.] Erdo 3(8): 267-70. [Hu.]

Welcer-Kawecka, A. 1955. JAKIE ROZMNAZANIE TOPOLI JEST KORZYSTNIEJSZE? [WHAT METHOD OF POPLAR PROPAGATION IS THE MOST ADVANTAGEOUS?] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 10: 223-31. 10 refs. [Pol.russ.e.]
Discusses the merits of propagation by seeds and by cuttings.

Zlataric, B. 1953. NEKE SAVREMENE METODE RAZMNOZAVANJA DOMACIH TOPOLA. [SOME MODERN METHODS OF PROPAGATING INDIGENOUS POPLARS.] Sum. List 77(6): 255-62. 2 refs. [Croat.e.]

232.324.1

Fleischer, E. 1957. MASCHINELLES PFLANZENHEBEN DURCH PFLANZENHEBEPFLUG "GRAUPA." [MECHANICAL LIFTING WITH THE "GRAUPA" PLANT-LIFTING PLOUGH.] Forst u. Jagd Spec. No. Die Pappel 2: 42-5. [G.]
Describes operations with a tractor-drawn plough in poplar nurseries, including working costs. It is claimed that even heavy soils are loosened sufficiently for easy lifting, and that roots suffer fewer injuries than with manual work.

232.328

Anonymous. 1923. THE ROOTING OF POPLAR CUTTINGS. Trans. Scot. Arbor. Soc. 37: 82.

Geyda, K. 1948. O TOPOLI I JEJ ROZMNAZANIU. [POPLARS AND THEIR PROPAGATION.] Wydaw. Pomocn. Tech. -Gosp. Inst. Bad. Lesn. No. 17, 84 pp. 15 refs. [Pol.]

Vincent, G., and Spalek, V. 1949/50. STANDARDNI OZNACENI TOPOLOVYCH SAZENIC A RIZKU. [STANDARD DESIGNATIONS FOR POPLAR PLANTS AND CUTTINGS (OF DIFFERENT VEGETATIVELY PROPAGATED GENERATIONS).] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 22 (2): 317-21. (Cz.russ.f.)

232.328.1

Bier, J. E. 1961. THE RELATION OF BARK MOISTURE TO THE DEVELOPMENT OF CANKER DISEASES CAUSED BY NATIVE, FACULTATIVE PARASITES. V. ROOTING BEHAVIOR AND DISEASE VULNERABILITY IN CUTTINGS OF POPULUS TRICHOCARPA TORREY AND GRAY, AND P. 'ROBUSTA'. Canad. J. Bot. 39(1): 145-54. 7 refs.

Cram, W. H. 1951. THE RELATION OF SIZE AND STORAGE OF CUTTINGS TO ROOTING CAPACITY OF POPLAR CLONES. Dom. For. Nursery Sta. Sask. 1 p.
Size of cutting had no apparent effect. Outdoor storage (heeling in) produced ca. 20% more rooted cuttings than cellar storage (in moist sand).

———— [1959.] NURSERY RESEARCH: MATURITY OF POPLAR CUTTINGS. Rep. Dom. For. Nursery Sta. Sask. 1958: 10.
Cuttings taken (a) on 9 Oct. and (b) on 29 Oct., stored out of doors and planted in the following May, did not differ significantly in moisture content, but (b) gave much superior establishment (53.5 vs. 42.7%) and height growth 112 days after planting (45.1 vs. 29.6 cm.).

Ford, H. F. 1954. EFFECT OF STERILIZING TREATMENTS ON SURVIVAL AND GROWTH OF HYBRID POPLAR CUTTINGS. U. S. For. Serv. Ntheast. For. Exp. Sta., For. Res. Note No. 33, 3 pp. 2 refs.

———— and Waterman, A. M. 1954. EFFECT OF SURFACE STERILIZATION ON SURVIVAL AND GROWTH OF FIELD-PLANTED HYBRID POPLAR CUTTINGS. U. S. Dep. Agr. Plant Dis. Reptr. 38(2): 101-5.

Gremmen, J. 1961. HETVOORKOMEN VAN GLOMERELLA MIYABEANA OP DE POPULIER. [G. MIYABEANA ON POPLAR.] Ned. Boschb.-Tijdschr. 33(5): 131-3. 5 refs. [Du.e.]

Harkai, L. 1960. DUGVANYKIHOZATALI VIZSGALATOK A BAJTI ORSZAGOS NYAR TORZSANYATELEPEN. [CUTTING PRODUCTION STUDIES IN THE STATE POPLAR CLONE GARDEN AT BAJTI.] Erdo 9(6): 201-4. 2 refs. [Hu.russ.g.]
Investigates in a new garden the cutting production of seven clones from a 4- to 5-year-old garden. It is considered that such gardens should be worked 7-8 years, then heavily fertilized and sown to agricultural crops for 1-2 years. The clones were of P. × canadensis, P. nigra and P. deltoides × P. italica.

Hyun, S. K. 1962. AUTORADIOGRAPHIC STUDIES ON THE ABSORPTION AND RETENTION OF ROOTING PROMOTERS WITHIN THE TISSUES OF POPLAR CUTTINGS. Res. Rep. Inst. For. Genet., Suwon No. 2: 5-19. 6 refs. [Kor.E.]

Joachim, H. -F. 1960. UBER UNTERSCHIEDLICHES ANWACHSEN VON PAPPELSTECKLINGEN IN PFLANZENSUCHTGARTEN. [DIFFERENCES IN ROOTING AND GROWTH BETWEEN POPLAR CUTTINGS IN NURSERIES.] Forst u. Jagd 10(2): 57-61. 4 refs. [G.]

Jovanovic, S. 1961. RESULTATI DEJSTVA NEKIH SINTETICKIH FITOHORMONA NA OZILJAVANJE REZNICA JASIKE (POPULUS TREMULA L.) I BELE TOPOLO (POPULUS ALBA L.). PRETHODNO ASOPSTENJE. [RESULTS OF THE ACTION OF SOME SYNTHETIC PHYTOHORMONES ON THE ROOTING OF P. TREMULA AND P. ALBA CUTTINGS. FIRST REPORT.] Sumarstvo 14(9/10): 359-69. 9 refs. [Serb.f.]

Jurhar, F. 1951. RAZMNOZEVANJE KANADSKEGA TOPOLA S POTAKNJENCI. [PROPAGATION OF CANADIAN POPLAR BY CUTTINGS.] Gozd. Vestn. 9(8): 177-82. 4 refs. [Sloven.]
General account based mainly on German sources.

Kemmer, C., and Vogl, M. 1960. ANTREIB- UND AUFZUCHTSVERSUCHE AN PAPPELN IM WINTER. [FORCING AND GROWING TESTS ON POPLARS IN WINTER.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 47 (Beitr. Pappelforsch. No. 5): 7-26. 13 refs. [G.g.-russ.e.]

Kobayashi, T., and Uozumi, T. 1961. [FUNGI FOUND ON DEAD PARTS OF THE TOP OF POPLAR CUTTINGS.] J. Jap. For. Soc. 43(7): 263-4. 2 refs. [Jap.]
One-year-old nursery cuttings of 10 poplar species were examined for fungus attack. The nine fungi identified and their respective hosts are tabulated, with their Latin names.

Koring; Joachim, H. F. 1954. MECHANISIERUNG DES PAPPELSTECKLINGSEINSCHNITTES. [MECHANIZED CUTTING OF POPLAR CUTTINGS.] Forst u. Jagd 4(12): 446-8. 1 ref. [G.]
Describes a machine equipped with a rotary knife for cutting poplar shoots into cuttings of suitable lengths, developed at the poplar nurseries of Rosenburg, E. Germany. The cut is smoother than a scissor cut, resulting in a conservation of moisture in the cutting, and in a dry spring successful takes were 80-90% for machine-cut vs. 40% for hand-cut material.

Koster, R., and Wijk, A. van. 1963. [PROPAGATING POPLARS BY SOFTWOOD CUTTINGS IN THE OPEN.] Ned. Boschb.-Tijdschr. 35(12): 464-9. 6 refs. [Du.du.e.e.]

Larsen, C. M. 1957. L'ENRACINEMENT INDIVIDUEL DES BOUTURES DE PEUPLIER. [INDIVIDUAL ROOTING OF POPLAR CUTTINGS.] Zuchter Spec. No. 4: 77-84. 3 refs. [F.f.]

Magnani, G. 1961(1962). UNA NECROSI CORTICALE IN TALEE DI PIOPPO. [A BARK NECROSIS OF POPLAR CUTTINGS.] Pubbl. Cent. Sper. Agric. For., Roma 5: 91-109. 12 refs. [It.it.e.e.]
The pathogen responsible for this condition was isolated and identified as Phomopsis sp. (probably P. pallida). It is apparently favored by even slight drying of the propagation material, and it is therefore advisable to immerse cuttings in water (not cold and stagnant) for 1-2 days before planting.

Matthews, J. D., and Jobling, J. 1961. PROPAGATION OF ELMS AND POPLARS FROM SUMMERWOOD CUTTINGS. Extr. from Rep. For. Res. For. Comm., Lond. 1959-60: 180-8. 2 refs.

Partos, G. 1957. NYARFELEK CSEMETENEVELESE VEGETATIV UTON. [THE VEGETATIVE PROPAGATION OF POPLARS.] Erdesz. Kutatas., Budapest 1957(3/4): 235-56. [Hu.hu.russ.g.e.]
Gives, in the English summary, full details of the optimum quality of cuttings (size, location, method of cutting, etc.), method and time of planting, and spacing.

Piskula, F. 1961. [A STUDY OF THE SUITABILITY OF VARIOUS TOOLS FOR MAKING POPLAR CUTTINGS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(2): 187-204. 8 refs. [Cz.cz.russ.g.]

Rubtov, S. 1952. O METODA DE BUTASIRE ORIZONTALA CU BUTASI FOARTE SCURTI. [THE WAY TO PLANT VERY SHORT CUTTINGS HORIZONTALLY.] Rev. Padurilor 67(4/5): 29-30. [Rum.rum.russ.]
An experiment was made in horizontal planting of very short (6-10 cm.) poplar cuttings, (a) in trenches 4 cm. deep and (b) in trenches 8-10 cm. deep: (a) gave 46% and (b) 19% rooting.

Samsiev, K. 1959. VLIJANIE DIAMETRA CERENKOV NA PRIZIVAEMOST I ROST SAZENCEV TOPOLEJ. [THE INFLUENCE OF THE DIAMETER OF POPLAR CUTTINGS ON SURVIVAL AND GROWTH.] Lesn. Hoz. 12(2): 69-70. [Russ.]

Schmitz-Lenders, B. 1953. FUSS-STECKLING ODER SETZRUTE BEI DER PAPPELPFLANZEN-ANSUCHT? [SHOOT BASE CUTTINGS OR SETTS IN RAISING POPLARS?] Forst u. Holz 8(1): 1-2. [G.]
Summarizes the advantages and disadvantages of cuttings without terminal buds (shoot base cuttings) and setts.

Sekawin, M. 1953. CONFRONTO FRA UN VIVAIO DI PIOPPO IMPIANTATO CON TALEE E UNO IMPIANTATO CON BARBATELLE. [COMPARISON OF A NURSERY PLANTED DIRECTLY WITH CUTTINGS AND ONE PLANTED WITH CUT-BACK ROOTED CUTTINGS.] In Studi e Ricerche sulla Pioppicoltura, Ente nazionale per la Cellulosa e per la Carta, Rome. Pp. 21-7. [It.]
It was found that by planting poplar cuttings in a temporary nursery, lifting them at the end of the year, and cutting back before planting out in the nursery beds, plants of better form were obtained and establishment was 88.6% compared with 56.1% for cuttings planted directly in the nursery.

Smith, J. H G., Haddock, P G., and Hancock, W V. 1956. TOPOPHYSIS AND OTHER INFLUENCES ON GROWTH OF CUTTINGS FROM BLACK COTTONWOOD (POPULUS TRICHOCARPA) AND CAROLINA POPLAR (P. CANADENSIS VAR. EUGENII). J. For. 54(7): 471-2 4 refs.

Strzelecki, W. 1955. Z BADAN NAD WPLYWEM STYMULATOROW WZROSTU NA UKORZENIANIE SIE ZRZEZOW TOPOLI. [INVESTIGATIONS

ON THE EFFECT OF GROWTH STIMULANTS ON THE ROOTING OF POPLAR CUTTINGS.] Sylwan 99(2): 160-6. 4 refs. [Pol.]

Suszka, B. 1963. [SURVIVAL AND DIMENSIONS OF ONE-YEAR POPLAR PLANTS IN RELATION TO THE LENGTH OF THE CUTTINGS AND THEIR LOCATION IN THE SHOOT.] Arbor. Kornickie, Poznan 8: 221-46. 17 refs. [Pol.pol.russ.e.e.]

Takagi, T. 1953. EFFECTS OF EXTERNAL H-ION CONCENTRATION ON ROOTING RESPONSES OF POPLAR STEM CUTTINGS IN NUTRIENT SOLUTIONS. J. Jap. For. Soc. 35(10): 309-12. 6 refs. [E.e.jap.]

Vamos, R., and Vida, L. 1963. [THE USE OF GROWTH REGULATORS FOR ACCELERATING THE ROOTING OF POPLAR CUTTINGS.] Erdo 12(2): 61-6. [Hu.russ.g.]
Both IAA and 2,4-D stimulated rooting. The former at 70 mg./litre can be applied with excellent results but the 2,4-D had side effects precluding its use. [Cf. Joachim, 1960, this subject classification.]

Vasilev, A. E. 1962. [THE EFFECT OF STIMULANTS ON CALLUS ACTIVITY.] Lesn. Z., Arhangel'sk 5(3): 31-2. 3 refs. [Russ.]

Vill. 1931. [SELECTION AND BEHAVIOR OF POPLAR CUTTINGS.] Mitt. Dtsch. Dendrol. Ges. 43: 324.

Walter, and Piesnack. 1957. UNTERSUCHUNGEN UBER VERSCHIEDENES SETZEN DER PAPPERSTECKLINGE. [TESTING DIFFERENT WAYS OF PLANTING POPLAR CUTTINGS.] Forst u. Jagd Spec. No. Die Pappel 2: 15-6. [G.]
Plants grown from cuttings buried vertically in the soil so that the top was covered with 1 to 2 cm. of soil exceeded in survival percent, height, weight of foliage and diameter growth those cuttings planted with the top bud protruding 1 to 2 cm. above ground (R. H. Muller's method as recommended in the "Pappelbuch" [cf. Hesmer, 1951, Populus sp., 0]).

Wareing, P. F., and Smith, N. G. 1963. PHYSIOLOGICAL STUDIES ON THE ROOTING OF CUTTINGS. Extr. from Rep. For. Res. For. Comm., Lond. 1961/62: 120, 124-5.

Waterman, A. M. 1954. SURFACE STERILIZATION OF HYBRID POPLAR CUTTINGS. U. S. For. Serv. Ntheast. For. Exp. Sta. Res. Note No. 32, 3 pp. 2 refs.

———— and Aldrich, K. F. 1952. SURFACE STERILIZATION OF POPLAR CUTTINGS. U. S. Dep. Agr. Plant Dis. Reptr. 36(5): 203-7. 7 refs.

———— and Aldrich, K. F. 1954. ADDITIONAL INFORMATION ON THE SURFACE STERILIZATION OF POPLAR CUTTINGS. U. S. Dep. Agr. Plant Dis. Reptr. 38(2): 96-100.

Wechselberger. 1953. FUSS-STECKLING ODER SETZRUTE BEI DER PAPPELPFLANZENANZUCHT. [SHOOT-BASE CUTTINGS OR SETTS IN RAISING POPLARS.] Forst u. Holz 8(5): 60-2. [G.]
Comments on the article by Schmitz-Lenders [1953, this subject classification].

232.328.5

Bokor, R. 1952(1954). UJ AGROTECHNIKAI MODSZER AZ IPARILAG ERTEKES FAT ADO U. N. NEMES NYARAK TENYESZTERULETENEK A KITERJESZTESERE A SZARAZABB TERMOHELYEK FELE. [A NEW METHOD FOR EXTENDING THE USE OF ECONOMICALLY VALUABLE POPLAR SPECIES TO DRIER AREAS.] Erdesz. Tud. Int. Evk., Budapest 2: 78-89. 4 refs. [Hu.russ.e.g.]

Gancev, P. 1957. VARHU OTZIVCIVOSTTA NA NJAKOI VIDOVE TOPOLI KAM PRISAZDANE. [THE REACTION OF SOME POPLAR SPECIES TO GRAFTING.] Izv. Inst. Gorata Balg. Akad. Nauk., Sofia No. 2: 121-42. 15 refs. [Bulg.bulg.russ.g.]

Lustig, E. 1956. VEGETATIVE VERMEHRUNG VON WERTHOLZERN IN DER FORSTWIRTSCHAFT. [VEGETATIVE PROPAGATION OF VALUABLE TIMBERS.] Forstarchiv 27(7): 154-7. [G.]
Describes graftings of scions from elite ash, on minus rootstocks, and the propagation, by grafting or budding, of material from individual poplars and maples with figured grain.

Pospisil, J. 1958. O AFINITE MEZI OSIKOU P. TREMULA L. A NEKTERYMI DALSIMI JEDINCI RODU POPULUS. [ON THE AFFINITY BETWEEN POPULUS TREMULA AND SOME OTHER REPRESENTATIVES OF THE GENUS POPULUS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 4(11): 1005-16. 10 refs. [Cz.cz.russ.e.]

Schonbach, H. 1960. BEOBACHTUNGEN AN HETEROPLASTISCHEN PFROPFUNGEN INNERHALB DER GATTUNG POPULUS. [HETEROPLASTIC GRAFTING WITHIN THE GENUS POPULUS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 47 (Beitr. Pappelforsch. No. 5): 27-41. 5 refs. [G.g.russ.e.]

232.329.9

Chen, Y.-M. 1962. [THE EFFECT OF GIBBERELLIN ON THE GROWTH OF POPLARS.] Lesn. Hoz. 15(12): 45-7. [Russ.]

232.4

Anonymous. 1941. ANPFLANZUNG UND KULTUR DER PAPPEL. [PLANTING AND CULTIVATION OF POPLAR.] Wbl. Papierfabrik. 72 (9): 114-8. Abstr. in Holz 4: 262. 1941. [G.]

———— 1948. POPLAR PLANTING. Leafl. For. Comm., Lond. No. 27, 14 pp.

Barbey, A. 1941. LA PLUS GRANDE PEUPLERAIE D'EUROPE. [THE LARGEST POPLAR PLANTATION IN EUROPE.] J. For. Suisse 92(7): 141-7. [F.]

Berta, F. 1959. NEHANY ADAT A PUSZTAVACSI ERDESZET NEMESNYAR TELEPITESEIROL. [POPLAR GROWING IN THE PUSZTAVACS FOREST DISTRICT.] Erdo 8(4): 144-8. [Hu.russ.g.]
Describes the planting, 1935-40, of 250 ha. of selected exotic poplars ("Edelpappeln"), ground preparation being 60- to 70-cm.-deep plowing with steam plows and planting at 1.5 × 1.5 m. The first tending was combined with agricultural intercropping; the first thinnings came after the 1945 liberation.

Bull, H., and Putnam, J. A. 1940. EARLY SURVIVAL OF COTTONWOOD AND HYBRID POPLAR PLANTATIONS AT STONEVILLE, MISSISSIPPI. U. S. For. Serv. South. For. Exp. Sta. Occ. Pap. No. 94, 7 pp.

de Cherisey. 1931. NOTE ON POPLAR PLANTATIONS IN FRANCE. Bull. Com. For., Paris 49.

Franco. 1932. PLANTING OF POPLARS IN ITALY. Rev. Eaux For. 70: 143.

Johnsson, H. 1943. POPPELKULTURER-INTRYCK FRAN EN STUDIERESA TILL BELGIEN OCH SYNPUNKTER PA POPPEL I SVENSK SKOGSBRUK. [POPLAR PLANTATIONS: IMPRESSIONS FROM A STUDY TOUR TO BELGIUM AND VIEWS ON THE POPLAR IN SWEDISH FORESTRY.] Svensk PappTidn. No. 9: 208-14. [Sw.] Plant Breed. Abstr. 14: 322. 1944.

Leather. 1927. A CHEAP FORM OF PLANTING [POPLAR CUTTINGS]. Quart. J. For. 21: 22.

Leslie, A. S. 1919. PLANTING OF POPLARS AT KININVIE. Trans. Scot. Arbor. Soc. 33: 71.

Lotbiniere. 1932. POPLAR PLANTATIONS IN ENGLAND. Quart. J. For. 26: 212.

Muller, R. 1958. DREI HILFEN FUR DEN PAPPELANBAU. [THREE HELPFUL RECOMMENDATIONS FOR POPLAR PLANTING.] Allg. Forstzeitschr. 13(8): 94-6. [G.]

Piccarolo, G. 1950. IL PIANTAMENTO DEL PIOPPO. [POPLAR PLANTING.] Ital. For. Mont. 5(6): 214-9. [It.f.e.]

Sarce. 1903. NOTE ON POPLAR PLANTATIONS IN BELGIUM. Bull. Soc. For. Belg. 10: 94.

Schmitz-Lenders, B. 1951. ANWEISUNG FUR DIE AUSFUHRUNG VON PAPPELANPFLANZUNGEN INNERHALB UND AUSSERHALB DES WALDES SOWIE FUR DIE HANDHABUNG DER PAPPEL-STAMMPFLEGE. [DIRECTIONS FOR MAKING POPLAR PLANTATIONS BOTH WITHIN AND WITHOUT THE FOREST AND FOR TENDING THE TREES.] Forst u. Holz 6(5): 65-6. [G.]

Smith. 1925. PLANTING IN DENMARK. Forstl Forsogsv. Danm 9: 3.

[U.S.A.: South. For. Exp. Sta.] 1947. [COTTONWOOD PLANTATION TECHNIQUE.] U. S. For. Serv., Rep. South. For. Exp. Sta. 1946: 14-15.

Vachat, F. du. 1939. PLANTATIONS OF POPLAR IN THE MARSH OF LA CHAUTAGNE (SERIAL). Rev. Eaux For. 77(4): 306-317. [F.]

———— 1939. THE POPLAR PLANTATIONS IN THE MARSH OF LA CHAUTAGNE (CONCLD.). Rev. Eaux For. 77(5): 403-413. [F.]

232.411.1

[Argentina: Mundo Maderero] 1958. CONTROL VARIETAL DE ALAMOS Y SAUCES. [CONTROL OF POPLAR AND WILLOW VARIETIES.] Mundo Maderero 18(215): 10. [Span.]
Discusses the recommendations of the Comision Nacional del Alamo, Argentina, designed to ensure that only good clones and varieties of poplar and willow planting stock, of known origin, are offered for sale. Clones recommended for planting in certain regions of Argentina, and for certain sites (e.g. along the sides of watercourses, etc.), are listed.

[Italy: Cellulosa e Carta] 1963. [STANDARDS FOR THE IDENTIFICATION, AUTHENTICATION AND GUARANTEEING OF MATERIAL FOR VEGETATIVE PROPAGATION AND PLANTING STOCK OF POPLARS.] Cellulosa e Carta 14(5): 3-5 [It.]
Standards drawn up by the executive committee of the Italian National Poplar Commission, which has recently instituted a register of poplar clones.

232.411.4

Cram, W. H. [1958.] 1957 REPORT ON BREEDING AND NURSERY RESEARCH. Dom. For. Nursery Sta. Sask. 6 pp. 2 refs.

[U.K.: For. Comm.] 1956. THE QUALITY OF POPLAR PLANTS. Leafl. For. Comm., Lond. No. 39, 8 pp.
Describes different types of planting stock (1-year rooted cuttings, ditto stumped and transplanted for 1 year ($C_1 + S_1$), $C_1 + S_2$, and unrooted setts), and methods of raising and handling them.

232.412

Jobling, J. 1960. EXPERIMENTS ON THE HANDLING OF POPLAR PLANTING STOCK. Extr. from Rep. For. Res. For. Comm., Lond. 1958/59: 161-7.

232.421

Meiden, H. A. van der. 1963. [THE SIZE OF PLANTING HOLES FOR POPLARS OVER ONE YEAR OLD.] Ned. Boschb.-Tijdschr. 35(11): 445-9. 1 ref. [Du.e.]

Nerincx, E. 1952. A PROPOS D'UNE PLANTATION DE PEUPLIERS A L'AIDE D'EXPLOSIFS. [PLANTING POPLARS WITH THE HELP OF EXPLOSIVES.] Bull. Soc. For. Belg. 59 (8/9): 400-4. [F.]

Podhorski, I. 1960. KAPTAZNI UZGOJ TOPOLA U PLANTAZAMA. [THE CHANNEL AND DRAIN METHOD OF RAISING POPLAR IN PLANTATIONS.] Sum. List 84(7/8): 220-2. [Croat.g.]

232.425.2

Pfort, E. 1957. ERGEBNISSE EINIGER DUNGUNGS- UND STARTVERSUCHE ZU PAPPEL, ROTEICHE UND DOUGLASIE. [SOME FERTILIZER AND STARTING TRIALS ON POPLAR, RED OAK AND DOUGLAS FIR.] Forst- u. Holzw. 12(7): 111-4. [G.]

232.427

Giacomelli, C. 1956. UN ATTREZZO PER IL RAPIDO PIANTAMENTO DELLE PIOPPELLE E DELLE TALEE DI PIOPPO. [AN IMPLEMENT FOR THE RAPID PLANTING OF POPLAR CUTTINGS AND YOUNG TREES.] Agricoltura Delle Venezie, Venezia 10(1): 31-7. [It.]

232.43

Anonymous. 1951. LA DENSITE DES PEUPLERAIES. [THE SPACING OF POPLAR PLANTATION.] Action For. Pisc. No. 160: 1-2. [F.]
A discussion, by several correspondents, of the various biological and economic factors involved in the choice of spacing.

Georgopulos, A. 1952. BEITRAG ZUR WAHL DES PFLANZVERBANDES BEI PAPPELKULTUREN. [THE SPACING OF POPLAR PLANTATIONS.] Schweiz. Z. Forstw. 103(6/7): 212-24. 12 refs. [G.f.]
Experience in Greece has shown that close spacing followed by thinnings is best both financially and silviculturally. On good sites a spacing of 2 × 2 m. is recommended, and on inferior sites, particularly on sandy soils, 3 × 4 m.

Herbignat, A. 1954. AVIS AUX PLANTEURS DE PEUPLIERS: DISTANCES A ADOPTER DANS LES PLANTATIONS. [ADVICE ON PLANTING POPLARS: SPACING IN PLANTATIONS.] Bull. Soc. For. Belg. 61(2): 92-107. [F.]

Miletic, S. 1961. PLANTACIJE TOPOLA NA POPLAVNOM PODRUCJU U GUSTOJ I RETKOJ SADNJI. [POPLAR PLANTATIONS ON PERIODICALLY FLOODED LAND AT CLOSE AND WIDE SPACINGS.] Topola, Beograd 5(24): 6-8. [Serb.f.]
Gives data on height and diameter increment over 4 or 6 growing seasons for 11 species or clones of poplar near the Danube at Bilje. Poplars planted at 2.5 × 2.5 m. had a mean height of 13.44 m. and d.b.h. of 14.33 cm. after 6 growing seasons vs. 15.12 and 20.73 for those at 5 × 5 m. The plots are being maintained to see which spacing gives the best return.

Trifunovic, D. 1961. ISTRAZIVANJA UTICAJA GUSTINE NA UKUPNI PRIRAST DEBLJINE I ZAPREMINE U SASTOJINAMA TOPOLA NA PODRUCJU PODUNAVLJA BACKE, BANATA, POTISJA I POSAVINE DONJEG SREMA. [RESEARCH INTO THE EFFECT OF POPLAR STAND DENSITY ON TOTAL DIAMETER AND VOLUME INCREMENT IN THE DANUBE REGION OF BACKA AND BANAT, AND THE TISA AND SAVA REGIONS OF LOWER SREM.] Sumarstvo 14(11/12): 465-84. 10 refs. [Serb.f.]

232.5

Cunningham, F. E. 1954. METHODS OF ESTABLISHING PLANTATIONS OF HYBRID-POPLAR CUTTINGS. U. S. For. Serv. Ntheast. For. Exp. Sta., Sta. Pap. No. 66, 10 pp. 10 refs.

Gjulmamedov, R. G. 1957. VYRASCIVANIE NASAZDENIJ BYSTRORASTUSCIH POROD NA OROSAEMYH ZEMLJAH MIL SKOJ STEPI PUTEM POSADKI CERENKOV. [GROWING STANDS OF QUICK-GROWING SPECIES BY DIRECT PLANTING OF CUTTINGS ON IRRIGATED LAND ON THE MILSK STEPPE.] Bjulleten Naucno-Tehniceskoj Informacii Azerbajdzanskogo Naucno-Issledovatel Skogo Instituta Lesnogo Hozjajstva i Agrolesomelioracii 1957(1/2): 35-9. [Russ.]
From abstr. in Referat. Z. (Biol.) 1958(4), No. 15405. [Russ.]

Marton, T. 1961. DUGWANYOZASSAL TORTENT NYARTELEPITES TAPASZTALATAI A KOZEPSOMOGYI HOMOKON. [EXPERIENCE WITH CUTTINGS IN POPLAR CULTIVATION ON SAND IN CENTRAL SOMOGY.] Erdo 10(12): 514-8. 5 refs. [Hu.russ.g.]
Following 50-60% damage by Saperda populnea to transplants and very little to cuttings in 1959, the latter are now preferred. Planting them in mixture (five varieties are named) is a mistake as otherwise resistant varieties get infected with Melampsora populi, though canker is generally absent.

Podhorski, I. 1955. O RAZMNAZANJU TOPOLA MOTKAMA. [PROPAGATION OF POPLAR BY SETTS.] Sum. List 79(9/10): 281-92. 9 refs. [Croat.croat.e.]

Schlenker, G. 1957. VERSUCHE MIT PAPPELSETZSTANGEN AUF SCHWEREM MERGELTONBODEN DES GIPSKEUPERS. [TRIALS WITH POPLAR SETTS ON A HEAVY MARLY-CLAY SOIL ON THE GYPSUM KEUPER.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 6: 63-4. [G.]

233 AFFORESTATION

Azy, B. D. 1947. BOISEMENT ET ENRICHISSEMENT DE LA FORET PAR LE PEUPLIER. [AFFORESTATION AND THE ENRICHMENT OF THE FOREST BY THE USE OF POPLARS.] Action For. Pisc. No. 116: 1. [F.]

Damke-Hornburg. 1954. PAPPELANBAU AUCH AUF STEIN- UND GEROLLHALDEN. [PLANTING POPLARS ON QUARRY SPOIL MOUNDS AND BOULDER BANKS.] Forst- u. Holzw. 9A(6): 122-3. [G.]

[Germany: Hilfe Durch Grun] 1960. LANDSCHAFT UND TAGEBAU. [LANDSCAPE AND OPEN-CAST WORKING, INCLUDING QUARRYING.] Hilfe Durch Grun, Darmstadt No. 9, 64 pp. Several refs. [G.]

Gunther, H. 1956. UNTERSUCHUNGEN UBER DIE VERWENDUNG VON PAPPELSTECKLINGEN ZUR KIPPENKULTIVIERUNG IN DER NIEDERLAUSITZ. [THE USE OF POPLAR CUTTINGS FOR THE REVEGETATION OF SPOILMOUNDS IN THE NIEDERLAUSITZ.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 16 (Beitr. Pappelforsch. No. 1): 51-70. 6 refs. [G.g.]

Hieronymus, H. 1956. BIOLOGISCHE MELIORATIONEN DURCH PERENNIERENDE LUPINE BEI DER REKULTIVIERUNG VON BRAUNKOHLEN-

KIPPEN. [BIOLOGICAL SOIL IMPROVEMENT BY PLANTING PERENNIAL LUPINS IN CONNECTION WITH THE REVEGETATION OF LIGNITE SPOIL-MOUNDS.] Forst u. Jagd 6(10): 465-6. [G.]
Good results were obtained in the Leipzig region by interplanting poplars, after cultivation, with perennial lupins. Planting the poplars as cut-back 1-year stock has proved successful and has reduced wind damage.

[International: FAO/For. Equipm. Note] 1961. POPLAR PLANTING ON SAND DUNES. For. Equipm. Note, FAO No. A.2 Tec. 61, 1 p.

Krolikowski, L., and Strzelec, Z. 1961. [TRIALS WITH SOME SPECIES AND FORMS OF POPLAR PLANTS IN AFFORESTING SANDY SOILS.] Roczn. Gleboznawcze, Warsz. 10 (Suppl.): 722-3. [Pol.]

Morgeneyer, W. 1961. ZUR VERWENDUNGSMOGLICHKEIT VON PAPPELN UND FLECHTWEIDEN BEI DER REKULTIVIERUNG NIEDERLAUSITZER BRAUNKOHLENKIPPEN. [THE USE OF POPLARS AND OSIER WILLOWS FOR THE REVEGETATION OF LIGNITE SPOIL MOUNDS IN THE NIEDERLAUSITZ REGION.] Forst u. Jagd 11(8): 344-7. 10 refs. [G.g.]
Summarizes results of research and experience as to planting methods, effect of fertilizers, and suitable varieties, with special attention to drought hardiness.

Stachy, J. 1960. ZADRZEWIANIE HALD POWEGLOWYCH W NIEMIECKIEJ REPUBLICE DEMOKRATYCZNEJ. [AFFORESTATION OF COAL-MINE SPOIL-MOUNDS IN E. GERMANY.] Sylwan 104(8): 35-44. 3 refs. [Pol.]
An account of experience at two sites, Laubusch (since 1949) and Mohlau (since 1926), mainly with poplars.

Tikos, B. 1938. [AFFORESTATION EXPERIMENTS ON "SZIK"-SOILS —CHIEFLY WITH POPLARS ON INLAND ALKALINE SOILS.] Erdesz. Lapok. 77(6): 514-21. [Hu.g.f.e.]

Toth, K. 1960. ALFOLDFASITAS-NYARFASITAS SZOLNOK MEGYEBEN. [AFFORESTATION AND POPLAR PLANTING ON THE HUNGARIAN GREAT PLAIN IN SZOLNOK COUNTY.] Erdo 9(5): 191-9. 5 refs. [Hu.russ.g.]
Since 1945 the forest area has been raised from 0.47 to 3.20%. Afforestation by area has been 51% pedunculate oak, 21% poplar, and robinia 10%. The poplars preferred are P. × robusta, P. nigra var. italica, and P. × regenerata.

[U.S.A.: Ntheast. For. Exp. Sta.] 1959. PLANTING ON COAL-STRIPPED LAND. U. S. For. Serv. Rep. Ntheast. For. Exp. Sta. 1958: 19-20.

235 UNDERPLANTING, ADVANCE PLANTING, ETC. NURSES AND FORMATION OF MIXTURES

Danszky, I., Rimler, L., and Rott, F. 1959. A GODOLLOI TAPASZTALATCSERE TANULSAGAI. [CONCLUSIONS DRAWN FROM AN EXCHANGE OF EXPERIENCES.] Erdo 8(12): 461-6. [Hu.]
Discusses the increasing of productivity by using shorter rotations, widely spaced "intermediate stands," e.g., poplars planted before or with a main stand of pines. From abstr. in Hung. Agric. Rev. 9(2): 17. 1960 [E.]

235.41

Costin, E. 1958. EFECTUL STIMULATOR AL ANINULUI NEGRU (ALNUS GLUTINOSA GAERTN.) ASUPRA CRESTERII SPECIILOR LEMNOASE PE NISIPURILE FLUVIO-MARITIME. [THE STIMULATING EFFECT OF A. GLUTINOSA ON THE GROWTH OF WOODY SPECIES ON FLUVIO-MARITIME SANDS.] Rev. Padurilor 1958(10): 573-7. 12 refs. [Rum. russ.g.f.e.]

Meiden, H. A. van der. 1961. DE ELS IN POPULIERENBEPLANTINGEN. [ALDER IN POPLAR PLANTATIONS.] Ned. Boschb.-Tijdschr. 33(6): 168-71. 3 refs. [Du.e.g.]

235.42

Ford, H. F., Williamson, M. J., and Cunningham, F. E. 1952. COVER CROPS NO SUBSTITUTE FOR CULTIVATION IN HYBRID POPLAR PLANTINGS. U. S. For. Serv. Ntheast. For. Exp. Sta. Res. Notes No. 14: 1-4.

[U.S.A.: Ntheast. For. Exp. Sta.] 1950. COVER CROPS FOR HYBRID POPLAR PLANTATIONS. U. S. For. Serv. Rep. Ntheast. For. Exp. Sta. 1949: 11.

235.5

Zmijanac, D. 1960. NEKE SMJERNICE ZA PLANTAZNI UZGOJ SUMSKOG DRVECA. [SOME DIRECTIONS FOR RAISING FOREST TREES IN PLANTATIONS.] Sum. List 84 (11/12): 371-8. [Croat.e.]

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Anonymous. 1935. DIE NACHZUCHT VON PAPPEL UND BAUMWEIDE IN DEN BADISCHEN AUEWALDUNGEN. [THE AFTER-CULTIVATION OF POPLAR AND WILLOW IN THE MEADOW WOODLANDS OF BADEN.] Forstabtlg. Badischen Finanz-u. Wirtschaftsministeriums. 16 pp.

Geisler, G. 1953. EINIGES ZUR FRAGE DES PAPPELANBAUS UND DER DRINGEND NOTWENDIGEN SCHUTZMASSNAHMEN FUR DIE PAPPEL. [THE PROBLEM OF POPLAR PLANTING AND THE URGENCY OF PROTECTIVE MEASURES.] Wald 3(9): 272-4. [G.]
Discusses the reasons for the frequent failures of recent plantings in Mecklenburg, estimated at 75% of all poplars planted since 1945, and stresses the need for correct choice of site and for tending in early years.

236.1

Jovanovic, S. 1959. UNISTAVANJE KUPINE (RUBUS CAESIUS L.) I BAGREMCA (AMORPHA FRUTICOSA L.) U POPULIKULTURI HERBICIDIMA. [CONTROL OF R. CAESIUS AND A. FRUTICOSA IN POPLAR PLANTATIONS WITH HERBICIDES.] Zast. Bilja No. 54: 53-67. 9 refs. [Serb.e.]
A longer version of an article listed below.

———— 1960. DEJSTVO NEKIH HERBICIDA NA VAZNIJE KOROVE U POPULIKULTURI. [THE ACTION OF SOME HERBICIDES ON IMPORTANT WEEDS IN POPLAR PLANTATIONS.] Topola, Beograd No. 15: 15-9. [Serb.f.g.]

Milewski, J. 1957. UPRAWA I PIELEGNACJA GLEBY POD PLANTACJAMI TOPOLOWYMI. [CULTIVATION AND TENDING OF SOIL UNDER POPLAR PLANTATIONS.] Las Polski, Warsz. 31 (15/16): 3-5. [Pol.]

236.1/3

Maran, B., and Lhota, O. 1952. BUREN-NAS NEJVETSI NEPRITEL PRI ZALESNOVANI A ZAKLADANI OCHRANNYCH LESNICH PASU. [WEEDS —OUR GREATEST ENEMY IN AFFORESTATION AND IN ESTABLISHING FOREST SHELTERBELTS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 25(1/2): 39-54. 11 refs. [Cz.russ.]

237 AMELIORATION OF FOREST SITES

Guerreiro, M. G. 1944. ASPECTOS ACTUAIS DA SILVICULTURA: O MELHORAMENTO. [PRACTICAL ASPECTS OF SILVICULTURE: FOREST AMELIORATION.] Agros, Lisboa 27(3/6): 150-7. [Port.]

237.4

[Belgium] 1953. LE PHOSPHATE THOMAS EN SYLVICULTURE. [THE USE OF BASIC SLAG IN FORESTRY.] Services Agronomiques des Producteurs de Phosphate Thomas, 47 Cantersteen, Brussels. 40 pp.
Deals for the most part with the Sart-lez-Spa experiment in fertilizing spruce but also gives some notes on the effects of applying basic slag at time of planting on fruit trees and poplars.

Chardenon, J. 1960. ETUDE DE L'ACTION DE DIVERS ENGRAIS. [FERTILIZER STUDIES.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris 1960(1): 1-9. [F.]

Felcourt, E. de. 1936. THE APPLICATION OF FERTILIZER TO POPLAR PLANTATIONS. C.R. Acad. Agric. France 22: 657-62. I.B.S.S. publ. relating to soils and fertilizers No. 64, p. 14. 1936.

Ithier, H. 1947. LA FUMURE DU PEUPLIER EST-ELLE RENTABLE? [DOES MANURING OF POPLARS PAY?] La Potasse, Mulhouse 21 (149): 186-8. 3 refs. [F.]

Mayer-Krapoll, H. 1956. DIE ANWENDUNG VON HANDELSDUNGEMITTELN INSBESONDERE VON STICKSTOFF IN DER FORSTWIRTSCHAFT. [THE USE OF COMMERCIAL FERTILIZERS, PARTICULARLY NITROGEN, IN FORESTRY.] Ruhr-Stickstoff Aktiengesellschaft, Bochum. 126 pp. 112 refs. [G.]

———— 1956. THE USE OF COMMERCIAL FERTILIZERS—PARTICULARLY NITROGEN—IN FORESTRY. Nitrogen Div., Allied Chem.

and Dye Corp., New York. 111 pp. 112 refs.
Transl. from Die Anwendung von Handelsdungemitteln insbesondere von Stickstoff in der Forstwirtschaft. Ruhr-Stickstoff Aktiengesellschaft, Bochum.

Meiden, H. A. van der. 1962. DIE DUNGUNG DER PAPPEL. [FERTILIZING POPLARS.] Forstarchiv 33(4): 69-72. 7 refs. [G.]

———— 1962. THE FERTILIZATION OF POPLARS. Commonwealth Forestry Institute, Oxford. BNB/U.K./Transl. No. 2600, 8 pp. Transl. by E. W. Jones from Forstarchiv 33(4): 69-72. 1962.

Van Tilt. 1928. GROWTH OF CANADIAN POPLAR AND USE OF FERTILIZER. Bull. Soc. For. Belg. 31: 76.

237.41

Contant, P. 1957. ESSAIS DE FUMURE SUR PEUPLIERS. [FERTILIZER TRIALS IN POPLAR PLANTATIONS.] Potasse, Mulhouse 31(249): 199-202. [F.]

Sekawin, M. 1960. NOTIZIE SULLA CONCIMAZIONE DEL PIOPPETO. [FERTILIZING POPLAR PLANTATIONS.] Cellulosa e Carta 11(5): 5-8. 8 refs. [It.it.f.e.g.]
Briefly reviews the literature and concludes that fertilizers are more effective when spread over the whole area rather than applied locally, and that best results are achieved by the use of a balanced NPK fertilizer.

237.417

Hilf, H. H., and Becher, R. 1962 and 1963. [THE VORWERKSBUSCH EXPERIMENTAL AREA. I. OBJECTS AND HISTORY. II. SHELTERBELTS AND WINDBREAKS. III. FERTILIZING AND SOIL CULTIVATION WHEN GROWING TIMBER OUTSIDE THE FOREST.] Holzzucht, Reinbek 16(3): 19-23; 17(1/2): 5-14. 8 refs. [G.]

237.43

Iturralde Irigoyen, A. 1963. [USE OF WASTE LIQUORS FROM SUGAR REFINERIES FOR SOIL IMPROVEMENT ON RIVER BANKS.] Montes, Madrid 19(112): 335-7. [Span.]

Koch, W. 1958. VON FRANZOSISCHER PAPPELWIRTSCHAFT. [POPLAR GROWING IN FRANCE.] Allg. Forstzeitschr. 13(7): 78-9. [G.]
A brief illustrated report of a study tour, including a description of the sewage disposal farm of Rheims, in which the water from the city sewers, including factory effluents, are used to irrigate a poplar plantation of 115 ha., begun in 1929, which shows a mean annual yield of ca. 14.5 cu.m.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Allegri, E. 1953. SUMMARY REPORT TO THE GOVERNMENT OF IRAQ ON POPLAR CULTIVATION. FAO, Rome. FAO/ETAP No. 8, 11 pp.

Anschutz, R. 1958. PAPPELANBAU INNERHALB UND AUSSERHALB DES WALDES IN DER PFALZ. [POPLAR GROWING INSIDE AND OUTSIDE THE FOREST IN THE PALATINATE.] Forst- u. Holzw. 13(2): 25-30. [G.]
A lecture on practical experiences with poplars both native and cultivars, largely in the forests of the flood-plains of the Rhine and its tributaries, including some figures on the extent of plantings, improvement of yield in such forests, etc., but also setbacks and disappointments.

Bauer, F. 1957. DIE AUFBRINGUNG VON PAPPELFASERHOLZ. [THE PRODUCTION OF POPLAR PULPWOOD.] Holz-Zbl. 83(36): 481-3. [G.]

Becking, J. H. 1954. OMLOOPSTIJD EN DUNNING VAN WIJD GEPLANTE POPULIEREN CULTUREN IN NEDERLAND. [ROTATION AND THINNING OF WIDELY SPACED POPLAR PLANTATION IN THE NETHERLANDS.] Ned. Boschb.-Tijdschr. 26(3): 57-65. 4 refs. [Du.g.]

Belgioioso, G. B. di. 1959. LA PIOPPICOLTURA NEL LODIGIANO. [POPLAR-GROWING IN THE PLAIN OF LODI.] Monti e Boschi 10(9): 475-85. [It.f.e.]
An account of the extensive plantations, with statistical data on area, increment, etc.

Beltram, V. 1953. VECJO POZORNOST GOJENJU TOPOLOV! [MORE ATTENTION TO POPLAR CULTIVATION!] Gozd. Vestn. 11(5): 129-32. [Sloven.]
A general account of poplar growing in Slovenia, with description of silvicultural methods to be adopted with poplar (Populus "canadensis").

Buchwald, K. 1951. BRUCHWALDGESELLSCHAFTEN IM GROSSEN UND KLEINEN MOOR, FORSTAMT DANNDORF (DROMLING). [FENLAND FOREST COMMUNITIES ON THE GROSSE AND KLEINE MOOR, DANNDORF (DROMLING) FOREST DISTRICT.] Angew. PflSoziol., Stolzenau No. 2, 46 pp. 17 refs. [G.]
Introductory sections on site factors, silvicultural and hydrological problems, followed by details of communities recognized (variants of the Alnetum glutinosae and Betuletum pubescentis) and soils (fen and bog types) in relation to groundwater level and composition, concluding with notes on poplar-growing on such sites and hydrological tasks.

Bura, D. 1962. [POPLAR PLANTATIONS WITH FIELD CROPS.] Sum. List 86(9/10): 297-316. [Serb.e.]

Chianese, L. 1951. POSSIBILITA DI SVILUPPO DELLA PIOPPICOLTURA IN TOSCANA. [POSSIBILITIES OF GROWING POPLAR IN TUSCANY.] Ital. For. Mont. 6(5): 239-43. [It.it.f.]

Claudel, Y. 1960. LES PLACEMENTS FORESTIERS. [FOREST INVESTMENT.] Bois Francais de Papeterie, Paris. 22 pp. 2 refs. [F.]
The author's aim is to indicate the possible returns on investment, with special reference to poplar plantations, and also the assistance available from the Fonds Forestier National in the form of loans, credits, subsidies, etc.

[Estonia: Eesti NSV Tead. Akad.] 1962. SALUMETSADE MAJANDAMISE KUSIMUSI. [SILVICULTURE OF BROADLEAVED AND BROADLEAVED/CONIFER STANDS.] Eesti NSV Teaduste Akadeemia (Zool. Bot. Inst.), Tartu. 190 pp. Many refs. [Est.russ.g.]

G.,H. 1952. RICHTLINIEN FUR DEN PAPPELANBAU DURCH DIE LANDSCHAFTSPFLEGE. [DIRECTIVES FOR THE PLANTING OF POPLARS UNDER THE "LANDSCHAFTSPFLEGE" ORGANIZATION.] Wald 2(4): 102-5. [G.]
Covers recommendations on planting, site selection and choice of species, tending and primary conversion in E. Germany.

Ganza, M. T. 1962. [POPLAR PLANTATIONS IN THE FLOODPLAINS OF SMALL RIVERS IN THE UKRAINE.] Lesn. Z., Arhangel'sk 5(5): 50-4. 4 refs. [Russ.]
Presents mensurational data for some Populus × 'canadensis' and P. nigra stands, and makes recommendations on sites, silviculture and management.

Georgopoulos, A. 1959. L'ESPACEMENT DANS LA PLANTATION DE PEUPLIERS ET LA POPULICULTURE INTENSIVE. [SPACING IN POPLAR PLANTATIONS AND INTENSIVE POPLAR CULTIVATION.] [Docum.] 10th Sess. Int. Poplar Comm. No. FAO/CIP/95E Add. 2, 4 pp. [F.]
After 4 years, plots in E. Macedonia spaced 2.5 × 3 m. had nearly twice the b.a. of plots spaced 5 × 6 m., and nearly 1/3 of the b.a. could be taken in a first thinning (a fact considered a definite advantage in a country where wood is scarce). Intercropping with maize in some of the widely spaced plots increased b.a. and mean diameter. [Cf. Georgopoulos, 1955, P. deltoides to P. generosa, 242.]

[Germany: Allg. Forstzeitschr.] 1961. FLURHOLZANBAU, DUNGUNG UND HOLZVERWERTUNG. [GROWING, FERTILIZING, AND UTILIZATION OF TIMBER CROPS OUTSIDE THE FOREST.] Allg. Forstzeitschr. 16(31): 445-61. Many refs. [G.]

[Germany: Holzzucht] 1957. HOLZERZEUGUNG AUF EHEMALS LANDWIRTSCHAFTLICH GENUTZTEN FLACHEN. [TIMBER GROWING ON FORMER AGRICULTURAL LAND.] Holzzucht, Reinbek 11(5/6): 41-3. [G.]

Giordano, E. 1962. [POPLAR-GROWING IN TURKEY.] Cellulosa e Carta 13(8): 5-13. [It.f.e.g.]
Of the indigenous Turkish species (Populus nigra, P. alba, P. tremula, P. euphratica, and P. suaveolens), only P. nigra is extensively grown. Its good form and rapid growth make this Turkish form worth trying elsewhere, and trials of 15 clones from Anatolia are in progress at Rome.

[Greece: Das. Chron.] 1960. HAI LEUKOPHYTEIAI TES MAKEDONIAS. STATISTIKA STOICHEIA DIA TEN PARAGOGEN XYLEIAS. [THE POPLAR PLANTATIONS OF MACEDONIA. STATISTICAL DATA ON WOOD PRODUCTION.] Das. Chron. 2(22/23): 1012-4. [Gk.]

Hesmer, H. 1962. [GROWING POPLARS IN INTENSIVELY MANAGED PLANTATIONS WITH AGRICULTURAL INTERCROPPING IN YUGOSLAVIA.] Forstarchiv 33(12): 241-8. 9 refs. [G.]
A report on a study tour, describing the program, which was inaugurated in 1959, and covering organization, plans, sites, varieties, plant raising, site preparation and fertilizing, planting and tending, agricultural crops, etc., with a brief note on the growing of tree willows.

Hristoskov, N. 1958. NASIJAT OPIT PO ZALESJAVANE S TOPOLI PO PORECIETO NA DUNAV. [EXPERIMENT ON AFFORESTATION WITH POPLARS ALONG THE BANKS OF THE DANUBE.] Gorsko Stopanstvo 14(4): 26-30. [Bulg.]

Houtzagers, G. 1952. DE POPULIER IN HET LANDBOUWBEDRIJF. [POPLARS ON AGRICULTURAL LAND.] Landbouwk. Tijdschr., Wageningen 64(10): 712-20. [Du.e.]
Discusses the value of additional timber production to the economy of the Netherlands, makes recommendations on choice of species and culture, gives some figures of price/cu.m. for P. gelrica, P. serotina, and P. marilandica, discusses the merits of line plantations along fields and roadsides and the best form of shelter plantations for the Netherlands, and urges experiments and a careful examination on the effect of shelterbelts on crops.

[International: FAO/Latin Amer. Poplar Conf.] 1956. EXPOSES NATIONAUX SUR LES POLITIQUES SUIVIES EN MATIERE DE POPULICULTURE REPUBLIQUE ARGENTINE. [STATEMENTS BY INDIVIDUAL COUNTRIES ON POPLAR CULTIVATION POLICIES. ARGENTINA.] [Docum.] FAO Latin Amer. Poplar Conf., B. Aires 1956 No. FAO/CIP/LAPC/3-A, 11 pp. [F.]

Jaime Fanlo, F. 1960. TECNICAS MODERNAS EN LA PLANTACION Y CUIDADOS CULTURALES DEL CHOPO. [MODERN TECHNIQUES IN THE PLANTING AND TENDING OF POPLARS.] Montes, Madrid 16(93): 233-53. [Span.]
A summary of information on the cultivation of poplars, including notes on selective breeding, nursery practice, the establishment of plantations, choice of varieties (with notes on some Spanish, French, and Italian clones), spacing, rotation, and tending.

Jakusenko, I. K. 1959. OB ISPOL'ZOVANII MELIORIROVANNYH BOLOT I ZABOLOCENNYH POCV POD KUL TURY TOPOLEJ. [UTILIZING DRAINED BOGS AND WATERLOGGED SOILS FOR POPLAR PLANTATIONS.] Lesn. Hoz. 12(11): 72-4. [Russ.]
Presents data from Belorussia showing that Populus × 'canadensis', P. trichocarpa, and P. alba do well on such sites, and advocates that increased use be made of poplars to improve this type of land which is at present used as pasture or low-yielding hayfields.

Joachim, H. F., and Wachter, H. 1962. [THE ESTABLISHMENT AND MANAGEMENT OF POPLARS IN "PLANTAGES" [INTENSIVELY TENDED PLANTATIONS].] Arch. Forstw. 11(10): 1059-84. 11 refs. [G.g.russ.e.]

Jobling, J. 1954. SILVICULTURAL EXPERIMENTS ON POPLARS. Rep. For. Res. For. Comm., Lond. 1952/53: 49-53.

Jovkovic, B. 1962. [MODERN POPLAR GROWING IN THE POSAVINA REGION OF BOSNIA.] Topola, Beograd 6(29/30): 25-30. [Serb.f.]
Discusses proposals, based on experience in N. Italy, for planting poplar in Posavina and compares the site conditions, especially temperature, rainfall and soil quality, of the two regions. Recommendations are presented to compensate for the differing conditions.

Karpati, I., and Toth, I. 1962. [THE TYPES OF FLOOD-PLAIN FOREST COMMUNITIES IN HUNGARY.] Acta Agronomica Academiae Scientiarum Hungaricae, Budapest 11(3/4): 421-52. 54 refs. [G.g.e.russ.]
Describes the chief types of softwood and hardwood flood-plain forests, and the silvicultural treatment recommended, with special reference to poplar growing. [Cf. Toth, 1960, Populus sp. 232.1.]

Klebe, H. 1954. PAPPELPFLANZUNGEN IN MEINEM GRUNEWALDREVIER. [POPLAR PLANTINGS IN THE GRUNEWALD DISTRICT.] Forst- u. Holzw. 9(23): 485-8. [G.]
Describes recent experimental plantings with a number of varieties, chiefly the "Harffer Pappel," along the Havel and on other —mostly nonforest—sites, giving details of planting methods, spacings, use of fertilizers, and site characteristics, including soil analyses [but hardly any results].

Kohan, S. 1959. PRISPEVOK K OTAZKE PESTOVANIA TOPOL'OV NA VYCHODOSLOVENSKEJ NIZINE. [GROWING POPLARS IN THE E. SLOVAKIAN PLAIN.] Lesn. Cas. 5(2): 105-42. 13 refs. [Slovak.russ.g.]

Lavezzini, A. 1958. COME DISPORRE LE PIOPELLE NEGLI IMPIANTI RAZIONALI. [THE RATIONAL LAY-OUT OF POPLAR PLANTATIONS.] Ital. Agric. 95(6): 321-30. [It.]
Discusses spacing and lay-out (e.g. single rows, rectangular, quincunx, etc.) illustrated by photographs, diagrams, and tables giving distances between plants and rows for different lay-outs.

Leroy, R. 1961. LIGNES ELECTRIQUES ET FONCTIONNEMENT DES CAPITAUX DANS LES PEUPLERAIES. [ELECTRIC TRANSMISSION LINES AND THE CAPITAL INVESTED IN POPLAR PLANTATIONS.] Rev. For. Franc. 13(5): 317-31. 4 refs. [F.]

Liekens, H. 1963. [POPLAR-GROWING IN BELGIUM.] Bull. Soc. For. Belg. 70(8/9;10;11): 401-39; 449-88; 519-36. 93 refs. [F.]
Covers area of plantations, varieties grown, nursery practice, plantation techniques, and research, with full literature references.

Lienard, U. G. 1950. COMMUNICATION SUR LA CULTURE DU PEUPLIER. [POPLAR GROWING.] Agricultura, Louvain 48(4): 198-230. [F.flem.]

Lopez-Cadenas de Llano, F. 1955. REBOISEMENT POPULICOLE EN ESPAGNE. [AFFORESTATION WITH POPLARS IN SPAIN.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 4, 8 pp. [F.]
Notes on areas planted, choice of species, planting methods, spacing, etc.

Lukjjanov, A. K. 1950. KULJTURY TOPOLEI V POIME REKI URAL. [POPLAR PLANTATIONS ON THE FLOODPLAIN OF THE R. URAL.] Lesn. Hoz. 3(3): 85-6. [Russ.]

Magyar, J. 1954. NYARASOK FATERMESE, SZERKEZETE ES KORSZERU NEVELESE. [YIELD, STRUCTURE AND MODERN TENDING OF POPLAR STANDS.] Erdesz. Kutatas., Budapest No. 2: 3-64. 12 refs. [Hu.]
From abstr. in Hung. Agric. Rev. 3(4): 8. 1954.

Marton, T. 1959. A SOMOGY MEGYEI NYARFABIZOTTSAG. [THE POPLAR COMMISSION OF COUNTY SOMOGY.] Erdo 8(4): 153-6. [Hu.russ.g.]
A description of the work, areas available for planting and the business of the first meeting and of the interests co-operating.

Mendes, J. L. 1960. LE PEUPLIER: L'ETAT ACTUEL DU PROBLEME AU PORTUGAL. [POPLAR-GROWING: THE PRESENT SITUATION IN PORTUGAL.] [Docum.] 7th Sess. FAO Jt. Subcomm. Medit. For. Probl., Lisbon 1960 No. FAO/SCM/60/5-Dd, 7 pp. [F.]
Includes tabulated data on the species, clones, and cultivars identified in Portugal.

Morelli, A. 1954. L'ASSESTAMENTO DELLA CONSISTENZA PIOPPICOLA. [MANAGEMENT OF POPLAR PLANTATIONS.] Agricoltura Delle Venezie, Venezia 8(8): 577-86. [It.]
Discusses the general problems of management in poplar plantations consisting of rows spaced well apart above agricultural crops, and gives detailed recommendations (with specimen forms) for drawing up working plans for them.

[Morocco: Min. Agric.] 1959. VERS UNE POLITIQUE DU PEUPLIER AU MAROC. [TOWARDS A POPLAR POLICY IN MOROCCO.] Ministere de l'Agriculture, Rabat. 1959. 35 pp. [F.]
Reviews the present status of poplar-growing in Morocco, research in progress, and possibilities of expansion in the future.

Mottl, J., and Peska, R. 1961. [THE HISTORY OF POPLAR GROWING IN OPOCNO REGION.] Sborn. Csl. Akad. Zemed. Ved (Lesn.) 7(2): 205-14. 5 refs. [Cz.cz.russ.e.]
Since the end of the 18th century.

[Netherlands: Staatsbosbeh.] 1961. POPULIERENTEELT. [POPLAR GROWING.] Staatsbosbeh., Utrecht. 8 pp. [Du.]
A semi-popular booklet containing advice on choice of species, site, planting methods, intercropping with agricultural crops or alternate lines of other tree species, and tending.

Noisette, A. 1958. LES PEUPLERAIES AUBOISES. [THE POPLAR PLANTATIONS OF AUBE.] Rev. Bois Appl. 13(2): 3-7. [F.]

Peace, T. R. 1951. POPLAR AS A FARM CROP. Agriculture (J. Minist. Agric., Lond.) 57(10): 473-7. 1 ref.
Suitable soils, methods of raising plants, pruning, recommended varieties, costs and returns. Assuming a rotation of 25 years, profit per tree is estimated at £4. 0s. 3d.

Piccarolo, G. 1951. LA PIOPPICULTURA NELLA VALLE PADANA. [POPLAR-GROWING IN THE PO VALLEY.] Ital. Agric. 88(6): 341-52. [It.]
Silvicultural methods and notes on genetics and taxonomy.

———— 1959. PIOPPICOLTURA E COLTURA ACCELERATA DELLE PIANTE DA LEGNO A RAPIDO INCREMENTO IN ITALIA. [POPLAR-GROWING AND SILVICULTURE OF OTHER FAST-GROWING WOODY SPECIES IN ITALY.] [Ente Nazionale per la Cellulosa e per la Carta, Rome.] 58 pp. [It.]
A paper presented at a meeting of the Italian section of TAPPI (Bari, Sept. 1959), dealing with breeding and trials of poplars, eucalypts, and fast-growing exotic conifers.

———— and others. 1958/1959. ASPETTI ED INDIRIZZI TECNICI E PRODUTTIVI DELLA PIOPPICOLTURA PIEMONTESE E DELLA COLTIVAZIONE ACCELERATA DI ALTRE PIANTE DA LEGNO. [TECHNICAL AND PRODUCTIVE ASPECTS AND TRENDS OF POPLAR-GROWING AND RAPID GROWING OF OTHER WOODY SPECIES IN PIEDMONT.] Annali Dell' Accademia di Agricoltura di Torino 101, 21 pp. [It.]

Plavsic, S. 1960. SAVREMENE AGROTEHNICKE MERE U GAJENJU TOPOLA KAO USLOV VISOKIH PRINOSA. [MODERN AGRICULTURAL TECHNIQUES IN THE CULTIVATION OF POPLARS AS A CONDITION OF HIGH YIELDS.] Sumarstvo 13(11/12): 505-12. 15 refs. [Serb.]
Summarizes a lecture on intensive poplar growing, covering mechanization and types of machinery, choice of site and planting stock, etc., given in June 1959 to a seminar organized by the Yugoslav National Poplar Commission.

Podhorski, I. 1960. AKTUELNI PROBLEMI PLANTAZNOG GAJENJA TOPOLA. [CURRENT PROBLEMS OF GROWING POPLARS IN PLANTATIONS.] Topola, Beograd No. 16: 2-9. [Serb.f.]
Discusses suitable soils, desirable types of planting stock, agricultural cultivation in plantations, yield at various ages on four site classes, and rotations (10-15 years is the period at present envisaged) in Yugoslavia.

Ponticelli, P. 1955. SVILUPPO DELLA PIOPPICOLTURA FERRARESE. [THE DEVELOPMENT OF POPLAR-GROWING IN THE PROVINCE OF FERRARA.] Cellulosa e Carta 6(12): 3-10. [It.f.e.]
The province consists for the most part of reclaimed (largely irrigated) land and much poplar has already been planted. The respective merits of special plantations and planting in strips along watercourses is discussed and decided in favor of the latter.

Regnier. 1959. LA CULTURE INTENSIVE DU PEUPLIER D'APRES LES EXPERIENCES ITALIENNES. [INTENSIVE POPLAR CULTIVATION ACCORDING TO EXPERIENCE IN ITALY.] C.R. Acad. Agric. France 45(15): 762-9. [F.]
A brief review following attendance at the meeting of the International Poplar Commission Conference in Italy in Sept.-Oct. 1959.

Saby, P. 1958. LE MARAIS POITEVIN: CONTRIBUTION AUX PROBLEMES DE LA PRODUCTION ET DU CUBAGE DES PEUPLIERS. [THE MARAIS POITEVIN: ON THE PROBLEMS OF YIELD AND MEASUREMENT OF POPLARS.] Rev. Bois Appl. 13(2): 8-12. [F.]

Samek, V. 1954. K EKOLOGII RYCHLE ROSTOUCICH DREVIN. [THE ECOLOGY OF FAST-GROWING TREES.] Lesn. Prace 33(6): 249-53. [Cz.]

Samsiev, K. S., and Dolgih, G. D. 1962. [THE YIELD OF POPLARS IN THE N. OF KIRGHIZIA.] Lesn. Hoz. 15(8): 45-6. [Russ.]

Soules, B. 1961. HE LEUKOKALLIERGEIA THRAKES. [POPLAR CULTIVATION IN THRACE.] Das. Chron. 3(10): 390-3. [Gk.]

[Switzerland: Foret] 1958. PLANTATION DE PEUPLIERS ET SOINS A LEUR DONNER. [PLANTING AND TENDING OF POPLARS.] Foret, Neuchatel 11(6): 126-31. [F.]
An official memorandum of the Swiss Poplar Society, giving advice on site requirements, spacing, pruning, and protection against fungus diseases, pests, domestic animals, etc.

Toth, I. 1961. A NYARASOK ERTEKTERMELESENEK ERDONEVELESI VONATKOZASAI. [THE RELATION OF SILVICULTURE TO VALUE PRODUCTION IN POPLAR STANDS.] Erdo 10(2): 41-5. [Hu.g.russ.]

Trajkov, L., Stevcevski, J., and Hadzigeorgiev, K. 1959. PODIGANJE I ODGLEDUVANJE TOPOLI VO POVARDARIETO—OD TITIV VELES DO GRCKATA GRANICA. [GROWING AND TENDING POPLARS IN THE VARDAR VALLEY [MACEDONIA]—FROM TITOV VELES TO THE GREEK BORDER.] Sum. Pregled, Skopje 7(4/5): 11-43. 19 refs. [Maced. russ.]
Deals with choice of site and planting stock, raising along with agricultural crops, site preparation, thinning, rotations, etc.

Tronco, G. 1959. PERTINENZE IDRAULICHE DEMANIALI E PIOPPICOLTURA. [STATE-OWNED ALLUVIAL LAND AND POPLAR CULTIVATION.] Cellulosa e Carta 10(5): 7-16. [It.f.e.g.]
Examines the legal, technical, and social implications involved in the granting of concessions for poplar growing on newly formed alluvial lands owned by the State in the flood plain of the Po, with particular reference to the hardships caused to small landowners whose property borders on the lands in question.

———— 1962. I "NEMICI" DEL PIOPPO. [THE "ENEMIES" OF POPLAR.] Ital. Agric. 1962(1): 6-21. [It.]
An illustrated account of defects (e.g. knots, reaction wood, low specific gravity, short fibers) due to faults in selection of planting stock, lay-out and spacing of plantations, thinning, pruning, etc.

Tyszkiewicz, S. 1957. TOPOLE W BASZKIRII. [POPLARS IN BASHKIRIA.] Sylwan 101(5): 67-75. [Pol.]

Ulrich. [1956.] DER DERZEITIGE STAND DER PAPPELWIRTSCHAFT UNTER BESONDERER BERUCKSICHTIGUNG DER ERFAHRUNGEN IM FORSTAMT DANNDORF. [THE PRESENT STATE OF POPLAR GROWING, WITH SPECIAL REFERENCE TO EXPERIENCE IN THE DANNDORF FOREST DISTRICT.] Ber. Tag. Nordwestdtsch. Forstver., Braunschweig 1955: 20-37. [G.]
An introduction to an excursion.

———— 1962. 15JAHRIGE ERFAHRUNGEN MIT PAPPEL UND ROTERLE IM FORSTAMT DANNDORF. [15YEARS' EXPERIENCE WITH POPLARS AND ALNUS GLUTINOSA IN THE DANNDORF DISTRICT.] Forst- u. Holzw. 17(2): 30-3. [G.]

Valente, E. G. 1957. PASTA PARA PAPEL OBTENIDO DE SALICINEAS DEL DELTA DEL PARANA. [PULP OBTAINED FROM SALICACEAE IN THE PARANA DELTA.] Montes, Madrid 13(78): 419-22. [Span.]

Wachter, H. 1961. BEITRAG ZUR DURCHFORSTUNGS- UND VERBANDSFRAGE BEI DER PAPPEL IN DER ELBAUE (1. MITTEILUNG). [THINNING AND SPACING PROBLEMS IN POPLAR STANDS ON THE ELBE ALLUVIUM (1).] Arch. Forstw. 10(11/12): 1279-94. 7 refs. [G.g. russ.e.]

Walter, M. 1959. MECHANISIERUNG DES PAPPELANBAUS UND DER PAPPELPFLEGE IM STFB NEDLITZ (KREIS ZERBST). [MECHANIZATION OF POPLAR PLANTING AND TENDING AT NEDLITZ STATE FOREST (ZERBST DISTRICT).] Forst u. Jagd. 9(3): 131-3. [G.]
Describes an electric circular saw for taking cuttings from stool shoots, the use of motor cultivators, lifting plows, etc., with notes on costs and time saved compared with manual work.

Wendt, G. 1960. ZU EINIGEN FRAGEN DES PAPPELANBAUES. [SOME PROBLEMS OF POPLAR GROWING.] Forst u. Jagd 10(10): 467-9. [G.]
Discusses the reasons for the poor results of the poplar planting program. Of ca. 40 million poplars planted in E. Germany from 1951 to 1959, ca. 50% failed or are very poor. It is hoped that the recent transfer of most of the poplar cultivation to the state forestry unit will result in a better selection of sites and varieties, better tending, and better growth.

24 TENDING OF STANDS AND TREES

[International: IUFRO] 1962. [EFFECT OF TENDING MEASURES.] Proc. 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2(1), Sect. 23, 12 pp. [F.G.e.f.g.]

242 THINNINGS

Constantinesco, N. 1958. A PROPOS DE LA CULTURE DES PEUPLIERS. [REMARKS ON POPLAR GROWING.] Schweiz. Z. Forstw. 109(3): 187-93. 7 refs. [F.g.]

Larue. 1931. THE THINNING OF POPLARS. Bull. Soc. For. Franche-Comte 19: 37.

Magyar, J. 1959. A NYARASOK ES BUKKOSOK ERTEKESEBB FATERMESENEK ERDONEVELESI VONATKOZASAI. [THE SILVICULTURAL ASPECTS OF THE PROBLEM OF PRODUCING HIGHER TIMBER VALUE FROM POPLAR AND BEECH STANDS.] Erdeszettud. Kozl., Sopron 1959(2): 25-50. [Hu.g.russ.]

Volkmann, J. 1961. UBER DIE RENTABILITAT VON PAPPEL-FASERHOLZ AUS ERSTDURCHFORSTUNGEN. [PROFITABILITY OF POPLAR PULPWOOD FROM FIRST THINNINGS.] Forstarchiv 32(6): 119-22. 1 ref. [G.]
Because available data on the problem are inadequate, the author presents a model computation (using some of Ratzel's data—1955, P. canadensis to P. davidiana, 524—and several simplifying assumptions) to help determine the profitability or otherwise of poplar pulpwood from first thinnings under German conditions.

245.1

Sekawin, M. 1962. LA POTATURA DEL PIOPPO: OPERAZIONE ECONOMICA. [THE PRUNING OF POPLAR: AN ECONOMIC OPERATION.] Cellulosa e Carta 13(6): 11-24. 13 refs. [It.f.e.g.]
Reviews some of the literature, illustrates good and bad practices by photographs, discusses the factors involved (e.g. species or variety of poplar, age of tree, type of planting stock, pruning season) and describes tools and equipment (e.g. a long-handled circular saw driven by compressed air, and an hydraulic elevator).

245.13

Benben, K. 1957. PODKRZESUJEMY MLODE TOPOLE. [PRUNING YOUNG POPLARS.] Las Polski, Warsz. 31(13): 4-6. [Pol.]

Meiden, H. A. van der. 1957. SNOEI VAN POPULIER, GEBASEERD OP KWALITEITSEISEN VAN DE HOUTINDUSTRIE. [PRUNING POPLARS TO FULFILL THE QUALITY REQUIREMENTS OF THE WOOD INDUSTRIES.] Ned. Boschb.-Tijdschr. 29(1): 1-7. [Du.e.]

245.17

Bol, M. 1962. SNOEIGEREEDSCHAPPEN VOOR POPULIER. [PRUNING TOOLS FOR POPLARS.] Ned. Boschb.-Tidjdschr. 34(4): 145-7. [Du.]
Time studies on pruning with hand tools suggested that the EIA chisel with a wooden mallet and the Folsche saw with Jiri teeth are suitable for pruning at heights of 3-5 m. and the Jiri saw with a light metal ladder for heights above 6 m. The various implements used are illustrated.

Castellani, P. 1961. LA "SCALETTA PORTATA" PER LA POTATURA DEL PIOPPA. [THE "PORTABLE LADDER" FOR USE IN PRUNING POPLARS.] Cellulosa e Carta 12(5): 31-2. [It.]
Describes, with photographs, a rigid tubular-metal ladder that can be fixed e.g. to a small agricultural tractor, and so moved rapidly from tree to tree.

245.19

Holmes, G. D. 1963. TRIALS OF 2,4,5-T FOR REMOVAL OF EPICORMIC SHOOTS ON HARDWOODS. Extr. from Rep. For. Res. For. Comm., Lond. 1961 62: 156-63. 3 refs.
Spraying with 2,4,5-T ester at 0.2-0.4% (acid) in water was effective in killing a large percent of epicormic shoots less than 1 year old on oak, poplar, and elm, but shoots more than 1 year old were usually not completely killed. [Cf. Wood and Holmes, 1960, below.]

Liese, W. 1957. ORIENTIERENDE UNTERSUCHUNGEN ZUR CHEMISCHEN ASTUNG VON PAPPELN. [PRELIMINARY TESTS ON "CHEMICAL PRUNING" OF POPLARS.] Forst- u. Holzw. 12(17): 297-8. 3 refs. [G.]

Wood, R. F., and Holmes, G. D. 1960. SILVICULTURAL INVESTIGATIONS IN THE FOREST: (A) SOUTH AND CENTRAL ENGLAND AND WALES. CHEMICAL METHODS OF PRUNING. Extr. from Rep. For. Res. For. Comm., Lond. 1958 59: 42.
Preliminary tests of spraying unwanted side branches with amyl 2,4,5-T gave promising results with poplars, but less so with epicormic branches of oak. If successful, it will result in a great saving in manpower for pruning.

25 TREATMENT OF DEFECTIVE, DERELICT OR VERY OPEN STANDS

Dediu, A. 1955. CONTRIBUTII LA AMELIORAREA ARBORETELOR DEGRADATE DIN LUNCA INUNDABILA A DUNARII SI DIN LUNCILE RIURILOR (ZAVOAIELE DE SALCIE SI PLOP). [THE IMPROVEMENT OF DEGRADED FOREST ON FLOODLAND AND RIVER BANKS IN THE DUNARII REGION (WILLOW AND POPLAR STANDS).] Rev. Padurilor 70(5): 209-11. [Rum.]

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

Bauer, F. [Editor]. 1956. PAPPELANBAU IN DER LANDWIRTSCHAFT. [AGRICULTURAL POPLAR GROWING.] Allg. Forstzeitschr. 11(6): 66-82. [G.]
A special number devoted to poplar growing outside the forest, including articles on opportunities and experiences on Keuper in Franconia, river valleys in Hesse, shelterbelts, etc., in the Lower Rhine region, and industrial waste lands in Bavaria. In an article on pruning (Moegling), MVC wound dressing (M. Barthel and Co., Regensburg) is recommended.

Dallimore. 1923. POPLARS FOR FARM LAND. Kew. Bull., p. 95.

263 IRRIGATED FORESTS

Traunmuller, J. 1957. DIE VERWENDUNG DER PAPPEL BEI DER AUWALD-VEREDELUNG IN OBEROSTERREICH. [POPLAR PLANTING AS A MEANS OF IMPROVING FLOODPLAIN WOODLANDS IN UPPER AUSTRIA.] Allg. Forstztg. 68(7/8): 95-7. [G.]
Briefly describes the chief site types and reports on the organizations, including supply of planting stock, finance, supervision, etc., of poplar plantings in the scattered holdings of small farmers, discussing establishment, varieties, mixtures, fertilizing, etc.

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC.; HEDGEROW TREES

Bakker, A. 1960. VERSLAG VAN EEN ONDERZOAK NAAR DE INVLOED VAN POPULIEREN OP GRASLAND. [THE INFLUENCE OF POPLARS ON GRASS.] Meded. LandbHogesch. Wageningen 60(9): 1-38. 16 refs. [Du.du.e.e.]

Croney, D., and Lewis, W. A. 1949. THE EFFECT OF VEGETATION ON THE SETTLEMENT OF ROADS. Proc., Conf. on Biol. Civ. Eng. (5th sess.), 1948. Inst. Civ. Eng., Lond. Pp. 195-202.

Federico, S. 1951. LA PRODUZIONE LEGNOSA DELLE ALBERATE CAMPESTRE DELLA PIANURA PADANA. [WOOD PRODUCTION OF HEDGEROW TREES IN THE PO VALLEY.] Monti e Boschi 2(11/12): 450-5. [It.f.e.]

Blech. 1957. MOGLICHKEITEN DES PAPPELANBAUS AN WASSERSTRASSEN. [POPLAR PLANTING POSSIBILITIES ALONG WATER-COURSES.] Holz-Zbl. 83(14): 153-4. [G.]
A general article by an engineer, containing as an appendix the "Directions on Poplar Planting on Federal Water-courses (1955)" issued by the W. German Ministry of Transport. These give official guidance on questions of site, protection of banks, floodwater flow, protection from wind, etc., including drawbacks involved.

[International: IUFRO] 1962. [SHELTERBELTS AND ALLIED SUBJECTS.] Proc., 13th Congr. Int. Union For. Res. Organ., Vienna 1961 Pt. 2(1) Sect. 11, 67 pp. Many refs. [E.F.G.e.f.g.]

Joachim, H. F. 1952. PAPPELANBAU AUSSERHALB DES WALDES. [GROWING POPLAR OUTSIDE THE FOREST.] Dtsch. Landwirtsch. 3(4): 213-20. 11 refs. [G.]

Jovanovic, J. 1956. STVARANJE SUMSKOG FONDA IZVAN SUMSKIH POVRSINA. [CREATING RESERVES OF TIMBER OUTSIDE THE FOREST.] Sumarstvo 9(1/2): 36-44. [Serb.e.f.]
Suggests planting Populus 'canadensis' along the network of canals in Croatia and Vojvodina; some small-scale plantations were made in Osijek in 1955 and experiences are described.

Lengyel, G. 1959. A NYARFATELEPITESI PROGRAMMAL KAPCSOLATOS SZOLNOK-MAGYEI TALAJVIZGALATOKROL. [RESULTS OF SOIL ANALYSES MADE IN THE SZOLNOK DISTRICT IN CONJUNCTION WITH A POPLAR PLANTING PROGRAM.] Erdo 8(10): 395-400. [Hu.russ.g.]
Tabulated data on poplar growing trials along the banks of irrigation canals.

Lesznyak, J. 1959. A KELETI FOCSATORNA KORNYEKENEK NYARFASITASI LEHETOSEGEI. [POSSIBILITIES OF RAISING POPLARS ALONG THE EASTERN MAIN CANAL.] Erdo 8(3): 98-102. [Hu.russ.g.]
This 98-km. canal with its included network of waterways offers 2670 ha. for poplar planting. Special attention should be paid to soil properties, soil cultivation and at least 2-3 years' tending of the plants. A wide spacing is important. Best growth now is of P. × robusta but P. × marilandica and P. nigra may outstrip it later.

Montanari, V. 1954. DIE SCHUTZWIRKUNG DES PAPPELANBAUS IM UBERSCHWEMMUNGSGEBIET DES PO. [THE PROTECTIVE EFFECTS OF POPLAR PLANTINGS IN THE FLOOD-PLAIN OF THE RIVER PO.] Holzzucht, Reinbek 8(1): 5-6. [G.]
During the flood of 1952 in the Polesine area, poplars with minimum diameters of 15-20 cm. effectively protected buildings round which they grew. More than any other species, they reduced flood damage to agricultural land, irrigation canals, etc., and were most resistant to undermining. By slowing down the receding flood waters they increased sedimentation.

Pearse, H. C. H. 1962. LIVE FENCES OF TIMBER POPLARS. N.Z. J. Agric. 104(2): 123, 125.
Describes the planting of Lombardy poplar poles 9-10 ft. long and 2-3 in. in diameter. After 3-4 years, when trees were firmly established, wires were stapled directly on to them to make a stockproof fence. The economic advantages of fences from timber poplars are discussed.

Podhorski, I. 1957. UZGOJ TOPOLA U DRVOREDIMA VAN SUME. [POPLAR CULTIVATION IN ROWS OUTSIDE THE FOREST.] Topola, Beograd No. 3: 185-204. 9 refs. [Croat.f.]
Discusses growing poplars along roads, waterways, etc., and considers root spread, crown projection, and increment.

Ponticelli, P. 1955. SVILUPPO DELLA PIOPPICOLTURA FERRARESE. [THE DEVELOPMENT OF POPLAR-GROWING IN THE PROVINCE OF FERRARA.] Cellulosa e Carta 6(12): 3-10 [It.f.e.]
The province consists for the most part of reclaimed (largely irrigated) land and much poplar has already been planted. The respective merits of special plantations and planting in strips along watercourses is discussed and decided in favor of the latter.

Prevosto, M. [1959?] COLTURA DI RIPA DEL PIOPPO E SUA INFLUENZA SULLA PRODUZIONE DI ALCUNE PIANTE ERBACEE. [THE EFFECT OF POPLAR-GROWING ALONG FIELD BORDERS ON THE YIELD OF SOME HERBACEOUS CROPS.] Ist Sperimentazione per la Pioppicoltura, Casale Monferrato, Italy. 14 pp. 12 refs. [It.f.e.]

Raschke, M. 1954. FLURHOLZANBAU ALS WINDSCHUTZ UND ZUR HOLZVERSORGUNG. [TIMBER GROWING OUTSIDE THE FOREST FOR WIND PROTECTION AND WOOD PRODUCTION.] Forst- u. Holzw. 9(24): 503-4. [G.]

Sanz-Pastor, D. J. M., and Pierola, F. de. 1955. LES PEUPLIERS ET L'HYDROLOGIE FORESTIERE. [POPLARS AND FOREST HYDROLOGY.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 2, 3 pp. [F.]
A note on the planting of poplars for the protection of stream banks in Spain.

Stettler, R. 1956. PAPPELANBAU AND FLUSSKORREKTION. [POPLAR GROWING AND RIVER TRAINING.] Schweiz. Z. Forstw. 107(8/9): 480-90. 14 refs. [G.]
A general article including recommendations for various situations and for row plantings and plantations, pure or mixed.

Szigethy, L. 1961. RIZSFOLDEK FASITASA. [TREE PLANTING IN RICE FIELDS.] Erdo 10(2): 73-6. [Hu.g.russ.]

Torroba, J. F. 1955. L'INFLUENCE DU PEUPLIER SUR LA RICHESSE BIOGENIQUE DES EAUX CONTINENTALES. [THE INFLUENCE OF THE POPLAR ON FRESH-WATER BIOLOGY.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 10, 3 pp. [F.]
Discusses the beneficial effect on the fish population of trees (especially poplars) growing on river and stream banks.

Toth, B. 1961. NYARFASITASI LEHETOSEGEK AZ ALFOLDI KOTOTT ES SZIKES TALAJOKON. [POPLAR CULTURE OPPORTUNITIES IN FARM PLANTING ON HEAVY AND SZIK SOILS.] Erdo 10(4): 129-39. [Hu.g.russ.]
Presents soil and growth data for poplars growing in a ditch and on a bank, with drawings of the root systems. On these artificially created sites, poplars may be grown in areas where the soil is otherwise unsuitable. Some such plantations are described in detail.

Toulson, L. 1963. A EXPLORACAO DO CHOUPO COMO FREATOFITA NO PERIMETRO DE REGA DO APROVEITAMENTO HIDROAGRICOLA DO RIO MIRA. [INVESTIGATION INTO THE USE OF POPLAR AS A PHREATOPHYTE IN THE IRRIGATION AREA OF THE RIO MIRO AGRICULTURAL AND IRRIGATION PROJECT.] Direccao Geral dos Servicos Florestais e Aquicolas, Lisbon. 9 pp. 21 refs. [Port.]
Discusses on the basis of a study of the soils, possibilities for poplar growing in this area.

Vries, P. G. de. 1962. [A STUDY ON THE INFLUENCE OF TREE SPACING ON VOLUME AND THE SHAPE OF THE STEM CROSS SECTION OF POPLARS GROWN IN SINGLE ROWS.] Ned. Boschb.-Tijdschr. 34(7): 238-48. [Du.e.e.]

Wurtz, A. 1955. ACTION DES FEUILLES DE PEUPLIER DANS DE PETITS BASSINS DE PISCICULTURE. [THE EFFECT OF POPLAR LEAVES ON SMALL FISHPONDS.] Bull. Franc. de Pisciculture, Paris 28(179): 41-52. [F.f.]

265/266

[Germany: Allg. Forstzeitschr.] 1958. DIE HOLZZUCHT AUSSERHALB DES WALDES IN BAYERN. [GROWING TIMBER OUTSIDE THE FOREST IN BAVARIA.] Allg. Forstzeitschr. 13(38): 557-8. [G.]
Describes, with quotations, a book of that title published anonymously in Munich in 1856. Nine species of poplar are mentioned, with indications of site requirements.

Hilf, H. H. 1953 and 1954. HOLZZUCHT, DIE TECKNIK DES FLURHOLZANBAUS. [GROWING WOOD OUTSIDE THE FOREST.] Holzzucht, Reinbek No. 16: 1-5, 1953; 8(1): 6, 1954. 46 refs. [G.]
A lecture chiefly discussing aims, systems (standard and coppice, special crops, etc.) with special reference to windbreaks of trees and shrubs, their composition and structure, choice of species, siting, etc., and to the uses and requirements of poplars.

Jovanovic, S. 1960. ZNACAJ LINEALNIH ZASADA TOPOLA BRZOG RASTA U SKLOPU POLJEZASTITNIH POJASEVA I PLANTASA. [THE SIGNIFICANCE OF PLANTED LINES OF FAST-GROWING POPLARS IN THE COMPLEX OF SHELTERBELTS AND PLANTATIONS.] Sumarstvo 13(1/2): 3-14. 12 refs. [Serb.f.]

266 SHELTERBELTS, WINDBREAKS

Hilf, H. H. 1951. WINDSCHUTS DURCH FLURHOLSANBAU. [PROTECTION AGAINST WIND BY FIELD PLANTINGS.] Forstarchiv 22(7/8): 106-9. 32 refs. [G.]
Discusses literature on shelterbelts and recommends a greater use of tall fast-growing trees, especially poplars, underplanted with slower growing species and shrubs, in order to increase the area protected by a single shelterbelt, thus freeing more land for agricultural crops.

[Italy] 1951. L'ALBERO E LA BONIFICA. [TREES AND LAND RECLAMATION.] Monti e Boschi 2(11/12): 435-510. [It.]
A special number with articles by several authors, dealing mainly with shelterbelt planting in Italy, and particularly with the use of poplars and eucalypts for this purpose.

Joachim, H. F. 1955. BEISPIELE ERFOLGREICHEN PAPPELANBAUES IN DER FELDFLUR UND UNTERSUCHUNGEN UBER DIE EINWIRKUNG VON PAPPELANPFLANZUNGEN AUF BENACHBARTE KULTUREN. [EXAMPLES OF THE SUCCESSFUL USE OF POPLARS [TO GIVE SHELTER] IN CULTIVATED LANDS AND RESEARCH ON THE EFFECT OF PLANTING POPLARS ON NEARBY CROPS.] Holzzucht, Lignikultur 9(2): 9-10. [G.]

Kraaijenoord, C. W. S. van. 1962. POPLARS AND WILLOWS AS SHELTER ON DAIRY FARMS. N.Z. J. Agric. 104(3): 215-220.
Evaluates several native and exotic species of poplars and willows as shelter species, and outlines the important factors in shelterbelt design, with particular reference to dairy farms.

Mazek-Fialla, K. 1957. ERFAHRUNGEN MIT DER PAPPEL BEI WINDSCHUTZAUFFORSTUNGEN. [EXPERIENCE WITH POPLARS IN SHELTERBELTS.] Allg. Forstztg. 68(7/8): 99-104. [G.]
Deals with the composition, establishment, sites, tending, etc., of shelterbelt plantings in the Vienna basin. Development has

led from 3 or more rows of poplar only, to belts of ca. 10 m. in width, consisting of 2 or more rows of poplar flanked by rows of other trees and shrubs. Root crops, interplanted on fertile sites, proved beneficial against weeds in the early stages.

Nageli, W. 1956 UBER DIE WINDSCHUTZWIRKUNG EINER ALLEE MIT ASTOLOSER BODENPARTIE. [ON THE WINDBREAK EFFECT OF TREE ROWS HAVING NO BRANCHES NEAR THE GROUND.] [Docum.] 12th Congr. Int. Union For. Res. Organ., Oxford 1956 No. IUFRO 56/11/15, 5 pp. 2 refs. [G.e.]

Panfilov, Ya. D. 1946. AGROTEKHNIKA ZASHCHITNYKH NASAZHDENI V OROSHAEMYKH KHOZYAYSTRAKH. [TECHNIQUE OF ESTABLISHING PROTECTIVE PLANTATIONS ON IRRIGATED FARMS.] Nauchny Otchet ENYALMI sa 1941-1942. Sel' Khozgis, Moscow. Pp. 69-81. Bblg. [Russ.]

27 ARBORETA, ARBORICULTURE FOR ORNAMENTAL PURPOSES

Kienitz. 1919. POPLARS FOR BEAUTIFYING AND IMPROVING FORESTS AND PARKS. Mitt. Dtsch. Dendrol. Ges. 28: 279.

271 ARBORETA

Philippis, A. de. 1958. NOTE SUR LE POPULETUM MEDITERRANEEN DU CENTRE D'EXPERIMENTATION AGRICOLE ET FORESTIERE DE L' ENTE NAZIONALE PER LA CELLULOSA E PER LA CARTA, ROME. [NOTE ON THE MEDITERRANEAN POPULETUM OF THE RESEARCH STATION FOR AGRICULTURE AND FORESTRY OF THE ENTE NAZIONALE PER LA CELLULOSA E PER LA CARTA, ROME.] [Docum.] 14th Sess. Stand. Exec. Comm. Int. Poplar Comm. Rome 1958 No. FAO/CIP/CP/17, 8 pp. [F.]
Describes the situation, soil, climate, etc., of the Populetum established in March 1958 near Battipaglia (Salerno) and the collection of mountain poplars at Cucullaro (Calabria) at 900 m. alt., with lists of varieties and their origins.

———— 1959. NOTE SUR LE POPULETUM MEDITERRANEEN. [THE MEDITERRANEAN POPULETUM.] [Docum.] 10th Sess. Int. Poplar Comm., Italy 1959 No. FAO/CIP/98 Add. 1, 5 pp. [F.]
Contains lists of Mediterranean and Near East clones cultivated, recent additions, and growth data on plants established in 1958 and 1959 in the Rome and Battipaglia (Salerno) populeta.

Pourtet, J., and Turpin, P. 1954. LE POPULETUM NATIONAL DE VINEUIL (LOIR-ET-CHER). [THE NATIONAL POPULETUM OF VINEUIL (LOIR-ET-CHER).] Rev. For. Franc. 6(1): 9-18. [F.]
Describes the soil, layout, etc., of the arboretum and also gives some figures for increment of various hybrids (P. serotina, P. robusta, P. regenerata) and of P. deltoides.

Vucetic, J. S. 1958. CENTRALNI POPULETUM "KOVILOVO" U PANCEVACKOM RITU—KOMPLEKSNO OGLEDNO POLJE ZA ISTRAZIVANJE SA TOPOLAMA. [THE "KOVILOVO" CENTRAL POPULETUM AT PANCEVACKO RITO [SERBIA], AN EXPERIMENTAL AREA FOR COMBINED RESEARCH ON POPLARS.] Topola, Beograd No. 8: 635-66. 15 refs. [Serb.f.]
Describes the layout, climate and edaphic conditions of the populetum, established in 1955 north of Belgrade. The species of poplar are listed, and intended lines of research are indicated.

273 ORNAMENTAL STREET AND ROADSIDE TREES

Wyman, D. 1962. SORTING THE WOODY ORNAMENTALS: POPLARS GOOD FOR PAPER WOOD AND ARID AREAS, NOT AS ORNAMENTALS. Amer. Nurserym. 116(11): 11, 89-93.
Lists 11 species, varieties and hybrids recommended for stocking by U. S. nurserymen and ca. 70 not recommended.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

323 FELLING AND SUBSEQUENT PRIMARY CONVERSION

Muller-Thomas, H. 1950. PAPPELHOLZEINSCHLAG: FALLEN, AUFARBEITEN, ENTRINDEN UND VERLCHNEN. [POPLAR LOGGING: FELLING, CUTTING UP, BARKING AND WAGES.] Forstarchiv 21(7/9): 92-9. [G.]
Notes on technique and tools, including data from time studies, where available.

323.12/13

Curro, P. 1963. [CLEARING THE FELLING SITE IN POPLAR PLANTATIONS.] Monti e Boschi 14(1): 27-30. [It.f.e.]

367.4

Hippoliti, G. 1963. [NEW TOOLS FOR STUMP GRUBBING IN POPLAR STANDS.] Holzzucht, Reinbek 17(1/2): 4-5. [G.]

378.44

Leblanc, L. 1957. HARDWOOD FLOTATION STUDIES AND THEIR APPLICATIONS. Pulp Paper Mag. Can. 58(5): 242-272. 2 refs. (Woodl. Sect. Index Canad. Pulp Pap. Ass. No. 1667 (B-9-b).)

4 FOREST INJURIES AND PROTECTION

Bura, D. 1960. ZASTITNE MERE U RASADNICIMA I PLANTAZAMA TOPOLA. [PROTECTIVE MEASURES IN POPLAR NURSERIES AND PLANTATIONS.] Topola, Beograd 4(13/14): 11-3. [Serb.f.]
Lists destructive diseases and fauna of Yugoslavia, with means of combating them.

Farsky, O. 1961. CHOROBY A SKUDCI TOPOLU NA GABCIKOVSKU. [DISEASES AND PESTS OF POPLAR IN THE [DANUBE FLOODPLAIN FORESTS OF THE] GABCIKOVO AREA.] Prace Brnenske Zakladny Ceskoslovenske Akademie Ved, Brno 33(3): 113-75. 3 pp. of refs. [Cz.g.g.]

[Germany: Forst- u. Holzw.] 1962. SONDERHEFT PAPPEL. [SPECIAL NUMBER: POPLARS.] Forst- u. Holzw. 17(12): 225-44. 28 refs. [G.]

Gyorfi, J. 1952. KRANKHEITEN UND SCHADLINGE DER PAPPELN IN UNGARN. [PESTS AND DISEASES OF POPLAR IN HUNGARY.] Acta Agronomica Academiae Scientiarum Hungaricae, Budapest 2(1): 41-79. 9 refs. [G.e.russ.]

[International: FAO/Near East Poplar Conf.] 1954. SECRETARIAT NOTE ON PESTS AND DISEASES. [Pap.] Near East Poplar Conf., Rome 1954 No. FAO/NEPC/5, 7 pp. [E.]
Notes on poplar pests and diseases generally, with a brief discussion of the probable situation in the Near East. A note on the transmission of poplar disease from one country to another (R. Rol, H. van Vloten, and T. Peace) is annexed.

[Jugoslavia: Topola] 1958. POSEBAN BROJ O ZASTITI TOPOLA. [A SPECIAL NUMBER DEVOTED TO POPLAR PROTECTION.] Topola, Beograd No. 6: 429-55. [Serb.some f.]

Kalandra, A. 1951. NEMOCI A SKUDCI TOPOLU. [DISEASES AND PESTS OF POPLARS.] Csl. Les 31(23/24): 523, 526-8. [Cz.cz.]
A general account of fungus and insect diseases and pests of poplar seedlings and adult trees.

Kuntz, J. E., and Riker, H. J. 1949. WINTER INJURY VERSUS DISEASE IN WISCONSIN POPLAR PLANTINGS. Abstr. in Phytopathology 39(1): 12.

Lechevalier, H. 1944. UN NOUVEL ENNEMI POUR LES SANLOS DE QUEBEC. [A NEW ENEMY OF WILLOWS IN QUEBEC.] Nat. Canad. 7(9/10): 210. [F.]

Passavaili. 1933. VEGETABLE AND ANIMAL ENEMIES OF POPLAR. L'Alpe 20: 192.

Regnier, R. 1937. CONTRIBUTION TO THE STUDY OF POPLARS AND OF THEIR PRINCIPAL ENEMIES. ORIGIN AND CLASSIFICATION OF POPLARS. Ann. Epiph. Phytogen. 3(4): 507-49. Biol. Abstr. 12(3): 4392. 1938.

Schwerdtfeger, F. 1949. PAPPELVORKOMMEN UND PAPPELKRANKHEITEN IM NORDWEST-DEUTSCHEN WALDE. [POPLAR PLANTATIONS AND DISEASES AND PESTS OF POPLAR IN THE FORESTS OF NW GERMANY.] Pappelwirtschaft, Mitt. Dtsch. Pappelvereins No. 2: 29-43. [G.]
A report on answers to a questionnaire sent in 1948 to 227 forest officers (public and private) covering only poplars grown as forest plantations, and dealing with (A) the occurrence of such plantations (size and location, age, and species), and (B) diseases and pests recorded.

Sinreich, A. 1955. PAPPELSCHADLINGE UND-KRANKHEITEN IN OSTERREICH IN DEN JAHREN 1951-1954. [PESTS AND DISEASES OF POPLAR IN AUSTRIA DURING THE YEARS 1951-54.] Anz. Schadlingsk. 28(1): 1-5. 2 refs. [G.]
Lists insect pests damaging roots, leaves and wood, also fungus diseases occurring on poplar during this period, with notes on the occurrence of outbreaks and their control.

[Spain: Montes, Madrid] 1955. TRATAMIENTOS DE CHOPOS. [THE CARE OF POPLARS.] Montes, Madrid 11(63): 237-9. [Span.]
Brief notes on some important insect pests and fungus diseases, and their control.

Swart. 1934. ZIEHT UND PFLANZT GESUNDE PAPPELN! [RAISE AND PLANT HEALTHY POPLARS!] Dtsch. Forstw. 16(79). [G.]

41 GENERAL TECHNIQUE OF FOREST PROTECTION. TYPES OF INJURY

Regnier, R. 1937. CONTRIBUTION TO THE STUDY OF POPLARS AND THEIR CHIEF ENEMIES. Ann. Epiph. Phytogen. 3(4): 507-49. Plant Sci. Lit. 7(15): 2. 1938.

412 SILVICULTURAL CONTROL

Moriondo, F. 1954. UN PERICOLO PER IL PINO: LA VICINANZA DEL PIOPPO. [A DANGER TO PINE: THE VICINITY OF POPLAR.] Monti e Boschi 5(4): 169-72. [It.f.e.]
Describes damage to young Pinus pinea at Orbetello by the rust Melampsora pinitorqua whose alternate host is poplar, with some account of measures taken to eradicate poplar.

414.4

Chardenon, J., and Taris, B. 1959. ACTION D'UN ORGANO-MERCURIQUE ET D'UN DERIVE NITRE DU PHENOL SUR LE DEVELOPPEMENT DE BOUTURES DE POPULUS. QUELQUES REMARQUES SUR LA REPRISE DE L'ACTIVITE CAMBIALE CHEZ LES POPULUS. [ACTION OF AN ORGANO-MERCURIC SUBSTANCE AND A NITRO DERIVATIVE OF PHENOL ON THE DEVELOPMENT OF POPLAR CUTTINGS. SOME REMARKS ON THE RESUMPTION OF CAMBIAL ACTIVITY IN POPLARS.] C. R. Acad. Agric. France 45(4): 138-40. [F.]

[France: Serv. Cult. Etud. Peuplier et Saule] 1961. ESSAIS PRATIQUES DES ORGANOMERCURIQUES EN PEPINIERE. [FIELD TESTS WITH ORGANO-MERCURY PREPARATIONS IN THE NURSERY.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris 1961(1): 1-5. [F.]

Taris, B., and Chardenon, J. 1959. QUELQUES REMARQUES SUR L'ACTION DU CHLORURE DE METHOXYETHYL MERCURE (3.5% DE MERCURE, 0.6% DE CHLORE) SUR L'ACTIVITE CAMBIALE ET LE DEVELOPPEMENT DES BOUTURES DE POPULUS. [SOME REMARKS ON THE ACTION OF METHOXYETHYLMERCURIC CHLORIDE (3.5% H AND 0.6% CL) ON CAMBIAL ACTIVITY AND GROWTH IN POPLAR CUTTINGS.] C. R. Acad. Agric. France 45(6): 280-1. [F.]

416 TYPES OF INJURY

Joachim, H. -F. 1957. UBER FROSTSCHADEN AN DER GATTUNG POPULUS. [FROST DAMAGE IN POPULUS.] Arch. Forstw. 6(9): 601-78. 133 refs. [G.g.russ.e.]

Peace, T. R. 1953. THE TESTING OF POPLARS FOR THEIR REACTION TO DISEASE. [Pre-issue] Proc. Congr. Int. Union For. Res. Organ., Rome 1953. Sect. 24 (No. 1/2). 8 pp. 6 refs. [F.]

Vasic, M. 1959. STETE OD VISOKE DIVLJACI U KULTURAMA TOPOLA. [GAME DAMAGE IN POPLAR PLANTATIONS.] Zast. Bilja No. 51: 31-8. 4 refs. [Serb.e.]

416.1

Agenjo, R. 1960. DOS PLAGAS DE LOS ALAMOS (POPULUS) ORIGINADAS POR "ARANUELOS" (YPONOMEUTA LATR.). [TWO SPECIES OF HYPONOMEUTA DAMAGING POPLARS.] Bol. Serv. Plagas For., Madrid 3(5): 97-114. [Span.]
Describes outbreaks of H. gigas in Tenerife and of H. padella rorella in Aranzueque, province of Guadalajara. Some points of taxonomy, and the distribution of Hyponomeuta spp. in Spain are reviewed.

Bellis, E. de. 1955. DE L'HIVERNAGE D'UNE TORDEUSE DES PEUPLIERS. [HIBERNATION OF A POPLAR TORTRIX.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-A, 2 pp. [F.]
Observations on the larva of an unidentified species of Semasia or Gypsonoma which hibernates in the buds of poplars. [*Cf. Vivani, 1953, this subject classification.*]

———— and Cavalcaselle, B. 1961. PROVE DI LOTTA CON ESTERI FOSFORICI CONTRO LE LARVE DEL CRITTORINCO (CRYPTORRHYNCHUS LAPATHI L.). [EXPERIMENTS IN THE CONTROL OF C. LAPTHI LARVAE BY PHOSPHORIC ESTERS.] Cellulosa e Carta 12(11): 6-13. 19 refs. [It.f.e.g.]

Boyer, M. G. 1960. OBSERVATIONS ON FOLIAGE DISEASES OF INTRODUCED POPLARS. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 16(2): 1-2.

Butin, H. 1957. DIE BLATT- UND RINDENBEWOHNENDEN PILZE DER PAPPEL UNTER BESONDERER BERUCKSICHTIGUNG DER KRANKHEITSERREGER. [THE LEAF- AND BARK-INHABITING FUNGI OF POPLARS, WITH SPECIAL REFERENCE TO PATHOGENIC SPECIES.] Mitt. Biol. Bundesanst. Land- u. Forstw., Berlin No. 91, 64 pp. 20 refs. [G.]
Lists 94 leaf- and 51 bark-inhabiting species, their synonyms, morphology, injuries, and hosts (including differential susceptibility). A preliminary chapter presents tabulated data on the frequency and distribution over the stem, of 20 species found on 5-year-old trees of Populus "canadensis" cv. robusta which had been killed by Dothichiza populea but were still standing.

Dance, B. W. 1958. THE TAXONOMY OF FUNGI CAUSING LEAF AND TWIG BLIGHTS OF NORTH AMERICAN POPLARS. Proc. 6th Mtg. Comm. For. Tree Breeding Can., Montreal 1958, Part 2: R15-R17.
Concludes that there are two fungi involved—Venturia populina (imperfect stage Pollaccia elegans) and V. tremulae (imperfect stage Fusicladium tremulae).

Doom, D., and Hille Ris Lambers, D. 1962. OVER HET MASSAAL VOORKOMEN VAN DE SCHIMMELLUIS PHLOEOMYZUS REDELEI H.R.L. OP POPULIEREN IN 1961 IN NEDERLAND. [A MASS OUTBREAK OF P. REDELEI ON POPLARS IN THE NETHERLANDS IN 1961.] Ned. Boschb.-Tijdschr. 34(6): 202-8. 2 refs. [Du.e.]

Drazic, M. 1961. OGLEDI HEMIJSKOG SUZBIJANJA JOVINOG SURLASA (CRYPTORRHYCHUS LAPATHI L.). [EXPERIMENTS IN CHEMICAL CONTROL OF C. LAPATHI.] Topola, Beograd 5(20/21): 16-8. 12 refs. [Serb.]

Farsky, O. 1956. ZOBONOSKA REVOVA—RHYNCHITES (= BYCTISCUS) BETULETI FABR. SKUDCEM TOPOLU NA GABCIKOVSKU. [R. BETULETI—A PEST OF POPLARS NEAR GABCIKOVO.] Lesn. Cas. 2(4): 331-61. 51 refs. [Cz.russ.g.]

Grujovska, M. 1959. PRILOG KON POZNAVANJETO NA MYCOSPHAERELLA POPULI AUERW. [NOTES ON M. POPULI.] Godisn. Sum. Inst., Skopje 4: 91-5. 5 refs. [Maced.g.]
M. populi has been identified from the leaves of poplars, particularly Populus nigra var. pyramidalis, in nurseries and plantations along the river Vardar.

[Italy: Ente Naz. Cellulosa] 1953. ATTI DEL CONGRESSO NAZIONALE DEL PIOPPO (ROVIGO 15 NOVEMBRE 1953). [PROCEEDINGS OF THE [ITALIAN] NATIONAL POPLAR CONFERENCE (ROVIGO 15 NOVEMBER 1953).] Pubbl. Ente Naz. Cellulosa Carta, Roma 1954. 257 pp. [It.]
The papers and discussions deal mainly with the economic aspects of poplar growing in Italy. An exception is a paper by D. Rui, G. Giraldi and F. Bellavite on poplar pests in Veneto, dealing

with outbreaks of (1) Phloeomyzus passerinii and (2) Dothichiza populea.

Knezevic, I. 1959. SEMASIA—STETNIK MLADIH TOPOLA. [SEMASIA, A PEST OF YOUNG POPLARS.] Topola, Beograd No. 9: 776-8. 1 ref. [Serb.]
Describes damage to seedlings by Semasia spp. in a nursery near Osijek, Croatia, by larvae feeding on and killing the terminal bud, provoking a broomlike growth of several shoots from a lower bud. Spraying fortnightly in spring with lindane [gamma BHC] and DDT did not give effective control, and silvicultural measures are recommended for the attacked plants.

Marks, G. C. 1963. SHOOT BLIGHT OF POPLARS CAUSED BY COLLETOTRICHUM GLOEOSPORIOIDES. Abstr. of thesis, in Dissert. Abstr. 24(4): 1332. [Univ. Wis.]

Miklos, I. 1958. POJAVA CVRCKA CERESA BUBALUS FABR. NA TOPOLAMA U NR HRVATSKOJ. [C. BUBALUS ON POPLAR IN CROATIA.] Topola, Beograd No. 6: 455-61. 6 refs. [Croat.g.]

Moriondo, F. 1961. RIPETIZIONE SPERIMENTALE DEL CICLO BIOLOGICO DI MELAMPSORA PINITORQUA ROST. [EXPERIMENTAL REPETITION OF THE LIFE CYCLE ON M. PINITORQUA.] Ital. For. Mont. 16(2): 73-7. [It.it.f.]
The author has demonstrated experimentally that this rust fungus can overwinter in the mycelial state in the tissues of poplar shoots in the climatic conditions of Florence. [Cf. Moriondo, 1954, P. canadensis to P. davidiana, 443.3, and Regler, 1957, Populus sp., 416.15.]

Pietri-Tonelli, P. de, Galletti, A., and Chiesa, G. 1959. [CONTROL OF CRYPTORRHYNCHUS LAPATHI ON POPLARS WITH CARPOSAN 50.] Contributi, Instituto di Ricerche Agrarie, Societa Montecatini, Milano 1957-58 Vol. 2: 9-21. 2 refs. [It.]
Describes experiments with brushing or spraying of a parathion preparation in Toscana and Lombardy, showing that treatments with concentrations not less than 0.1% active principle gave excellent control. Best time would be February-March in central, and March-April in northern Italy. [Cf. Bellis and Cavalcaselle, 1961, this subject classification.]

Regler, W. 1953. AUFTRETEN EINES NEUEN PAPPELSCHADLINGS IN DER DDR. [APPEARANCE OF A NEW POPLAR DISEASE IN THE DDR [EASTERN ZONE OF GERMANY].] Wald 3(10): 312-3. 6 refs. [G.]
Reports the occurrence of Septogloeum populiperdum in poplar nurseries in E. Germany, Populus robusta, P. berolinensis, P. "canadensis" Leipzig, P. trichocarpa, and P. bachelierii being mentioned, describes the symptoms and suggests precautions against its spreading.

Savescu, A. 1955. O SPECIE NOUA DE PADUCHI TESTOSI, PADUCHELE VIRGULA AL PLOPULUI (LEPIDOSAPHES POPULI SAVESCU N. SP.) (COCCOIDEA-DIASPIDIDAE). [A NEW SCALE INSECT, THE POPLAR TWIG SCALE (L. POPULI SP. NOV.)] Bull. Sti. Acad. Repub. Rom. (Sect. Biol.) 7(4): 915-25. 6 refs. [Rum.russ.f.]
Describes a new scale insect, first recorded in 1944 near Ploesti, and since then in six other localities in Rumania. It attacks poplars, robinia, willow, and ash and is particularly dangerous to the first two. It is parthenogenetic, and differs from L. ulmi in having only one generation annually.

Schefer-Immel, V. 1959. DIE ZIKADE IDIOCERUS DECIMAQUARTUS SCHRK. ALS PAPPELSCHADLING. [I. DECIMAQUARTUS AS A PEST OF POPLAR.] Anz. Schadlingsk. 32(10): 150-5. 14 refs. [G.]
Presents data on biology and life history, based on observations made during a severe outbreak in 1958-59 in Frankfurt.

Sinreich, A. 1952. DER KAFERFRASS DES GROSSEN PAPPELBOCKES, SAPERDA CARCHARIAS L. [THE FEEDING PATTERN OF ADULTS OF S. CARCHARIAS L.] Mitt. Forstl. VersAnst., Mariabrunn 48: 168-70. [G.]
Gives photographs and a drawing of the holes eaten in poplar leaves. Holes due to feeding by beetles of this species may be recognized by their serrated margins.

Smereka, E., and LeJeune, R. R. 1953. LEAFHOPPERS ATTACKING POPLAR. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 9(6): 2.
The following leafhoppers have been collected from poplars in the prairie provinces where they cause considerable damage: Idiocerus lachrymalis, I. suturalis, Oncometopia lateralis, Macropsis sp., Oncopsis sp., and Agallia sp.

Templin, E. 1957. TIERISCHE BLATTSCHADLINGE AN PAPPELN. [LEAF PESTS ON POPLARS.] Forst u. Jagd Spec. No. Die Pappel 2: 17-36. 24 refs. [G.]
An illustrated account of leaf-mining, leaf-sucking, gall-producing, and leaf-eating insects and mites, their systematics, bionomics, economic importance, distribution, host preference, etc., and control, including a list of suitable E. German preparations for dusting or spraying.

Vivani, W. 1953. UNA ANORMALE E DANNOSA RAMIFICAZIONE APICALE NELLE GIOVANI PIOPPELLE. [AN ABNORMAL AND HARMFUL APICAL RAMIFICATION OF YOUNG POPLAR SEEDLINGS.] In Studie e Ricerche Sulla Pioppicoltura, Ente Nazionale per la Cellulosa et par la Carta, Roma. Pp. 9-19. [It.]
The condition is due to the larvae of several species of Semasia which oviposit in the terminal buds. The parasitization of the larvae by a species of Bracon is described. Control can also be effected by early removal of infested shoots, which should be cut back to a healthy bud.

———— 1955. NOTE BIOLOGICHE SULL'AFIDE LANIGERO DEL PIOPPO (PHLOEOMYZUS PASSERINII SIGNORET). [BIOLOGICAL NOTES ON THE POPLAR WOOLY APHID, P. PASSERINII.] Cellulosa e Carta 6(1): 7-12. [It.f.e.]
Describes the development and life history of the insect and explains the methods used to test the resistance of different poplar clones. Results of tests show that "Canadian poplar," P. euroamericana f. I 28 and f. I 65 are very susceptible, whereas I 214 and I 455, "Caroline poplar" and P. alba Linn. are almost immune.

Young, C. W. T. 1963. TESTING OF POPLARS AND PINES AGAINST PINE TWISTING RUST, MELAMPSORA PINITORQUA. Extr. from Rep. For. Res. For. Comm., Lond. 1961/62: 137-40. 3 refs.

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Anchierri and Grivaz. 1952. POUDRAGE INSECTICIDE DANS LA PEUPLERAIE DOMANIALE DE CHAUTAGNE. [INSECTICIDAL DUSTING IN THE STATE POPLAR PLANTATIONS OF CHAUTAGNE.] Rev. For. Franc. 1952(10): 752-8. [F.]

Anders, O. 1958. VORLAUFIGE UNTERSUCHUNGSERGEBNISSE UBER DIE LEBENSWEISE DES PAPPELKNOSPENWICKLERS SEMASIA OPPRESSANA TR. UND DES PAPPELTRIEBWICKLERS SEMASIA ACERIANA DUP. [PRELIMINARY INVESTIGATIONS INTO THE LIFE HISTORY OF S. OPPRESSANA AND S. ACERIANA.] Anz. Schadlingsk. 31(7): 101-7. 14 refs. [G.]

Bellis, E. de. 1958(1959). CONTRIBUTO ALLA CONOSCENZA DELLA BIOLOGIA DELLA GYPSONOMA ACERIANA DUP. [CONTRIBUTION TO THE KNOWLEDGE OF THE BIOLOGY OF G. ACERIANA.] Pubbl. Cent. Sper. Agric. For., Roma 2: 3-22. 14 refs. [It.it.e.e.]

———— 1960. PROVE DI LOTTA CHIMICA CONTRO LA PHYLLOCNISTIA SUFFUSELLA Z. [TESTS OF CHEMICAL CONTROL OF P. SUFFUSELLA.] Pubbl. Cent. Sper. Agric. For., Roma 4: 225-30. [It.it.e.]

Burmann, K. 1956. KLEINFALTERRAUPEN AN PAPPELN IN NORDTIROL. [LEPIDOPTEROUS LARVAE ON POPLARS IN THE NORTHERN TIROL.] Anz. Schadlingsk. 29(9): 145-6. [G.]
Lists 45 lepidopterous species, where found, and on what poplar species.

Ciferri, R. 1951. NOMENCLATURA DEL FUNGO CHE CAUSA LA 'DEFOGLIAZIONE PRIMAVERILE' DEI PIOPPI. [NOMENCLATURE OF THE FUNGUS CAUSING SPRING DEFOLIATION OF POPLARS.] Notiz. Malatt. Piante No. 14: 88, 103. 4 refs. [It.e.]
The pathogen is renamed Endostigma populina (Vuill.) n. comb. (= Didymosphaeria populina Vuill.; = Venturia populina Fabr.). Synonyms of the conidial stage Pollaccia elegans, are probably Stigmina populi and Septogloeum rhopaloideum.

Dafauce, C. 1959. NOTAS SOBRE STILPNOTIA SALICIS L. EN ESPANA. [NOTES ON S. SALICIS IN SPAIN.] Bol. Serv. Plagas For. Madrid 2(3): 41-6. [Span.]

Francke-Grosman, H. 1961. UBER EINE BEMERKENSWARTE PAPPELBLATTWESPE, STAURONEMA COMPRESSICORNIS (FABR.) BENSON.

[S. [PRISTIPHORA] COMPRESSICORNIS, A REMARKABLE SAWFLY FEEDING ON POPLAR LEAVES.] Z. PflKrankh. 58(1/2): 20-5. 2 refs. [G.]

Frediani, D. 1955(1956). NOTIZIA SULLA STILPNOTIA SALICIS L. ED ALCUNI SUOI PARASSITI ED IPERPARASSITI NELLA TOSCANA LITORANEA. [S. SALICIS AND SOME OF ITS PARASITES AND HYPERPARASITES IN THE TUSCAN COASTAL REGION.] Annali Della Facolta di Agraria, Pisa (n.s.) 16(1): 47-53. 13 refs. [It.]
Gives life history, and damage caused by the pest on poplars in Tuscany, and some account of its parasites (carcelia gnava, Apanteles solitarius, Telenomus mayri), and a hyperparasite (Dibrachys affinis).

Gremmen, J. 1956. EEN BLAD- EN TWIJGZIEKTE VAN POPULIEREN VEROORZAAKT DOOR VENTURIA TREMULAE EN VENTURIA POPULINA. [LEAF AND TWIG DISEASE OF POPLARS CAUSED BY V. TREMULAE AND V. POPULINA.] Tijdschr. PlZiekt. 62(5): 236-42. 9 refs. [Du.e.] (Korte Meded. Bosbouwproefsta. T.N.O., Wageningen No. 27.)

Grio, M. 1951. LA LUCHA BIOLOGICA CONTRA EL BICHO DE CESTO Y LA POSIBILIDAD DE SU EMPLCO. [BIOLOGICAL CONTROL OF OIKETICUS KIRBYI AND ITS POSSIBILITIES.] Cieno. & Invest., B. Aires 7(5): 195-202. 7 refs. [Span.]

Jahn, E., Wettstein, O., and Sinreich, A. 1960. SCHADLINGSBEFALLSFOLGEN IN EINEM WINDSCHUTZGEHOLZSTREIFEN BEI TADTEN IM BURGENLAND. [PESTS ATTACKING SUCCESSIVELY A SHELTERBELT IN TADTEN, BURGENLAND [AUSTRIA].] Allg. Forstztg. 71(15/16): Suppl. (Informationsdienst No. 35). 2 pp. 4 refs. [G.]

Jancke, G. D. 1959. THE WILLOW MOTH A PEST OF FRUIT ORCHARDS TOO. Fmg. S. Afr. 35(7): 19, 21.

Kopsacheilis, G. 1959. KATAPOLEMESIS TON ENTOMON LEUKES. [CONTROL OF POPLAR INSECT PESTS.] Das. Chron. 1(12): 541. [Gk.]
Brief report on successful control of Gypsonoma aceriana attacking nursery seedlings of poplar, especially Populus nigra var. italica, by spraying with a fresh mixture of BHC, aldrin, and Plantex [unspecified] in water.

Kuteev, F. S. 1960. OL'HOVYJ SKRYTNOHOBOTNIK—OPASNYJ VREDITEL' TOPOLJA. [CRYPTORRHYNCHUS LAPATHI—A DANGEROUS PEST OF POPLAR.] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 43: 5-18. 6 refs. [Russ.]

Li, Y. -C. 1959. [PRELIMINARY RESULTS OF TESTS ON THE USE OF INSECTICIDES TO CONTROL THREE SPECIES OF INSECTS DAMAGING THE LEAVES OF POPLARS.] For. Sci., Peking No. 4: 321-6. 4 refs. [Chin.russ.]

Martelli, G. 1957. LA GEMMAIOLA DEL PIOPPO. [THE POPLAR BUDWORM.] Giornale d'Italia Agricola, Roma No. 26. [It.]
From abstr. in Ital. Agric. 7(94): ii-iii. Poplar nurseries in Italy are often infested by a Gypsonoma sp. causing malformations of buds and leaders. It has been wrongly identified with G. neglectana, but differs in having two generations in the year instead of one. Control by picking off infested buds or spraying with a mixture of DDT and parathion is recommended.

Martelli, M. 1954. LA PRISTIPHORA CONJUGATA DAHLB. (HYMENOPTERA TENTHREDINIDAE) IN TOSCANA. [P. CONJUGATA IN TUSCANY.] Redia, Firenze (Ser. 2) 39: 157-85. 24 refs. [It.it.e.]
Gives an account of the Pristiphora spp. occurring in Italy, their distribution, hosts, etc., and a detailed description of P. conjugata, life history, parasites, and suggested control measures, in poplar plantations.

Miklos, I. 1960. PYGAERA ANASTOMOSIS L.—NOVI STETNIK NA TOPOLAMA. [P. ANASTOMOSIS, A NEW PEST OF POPLARS.] Sum. List 84(11/12): 368-70. 8 refs. [Croat.e.]
Gives description, and notes on biology and life history. Though defoliation by the pest has been noted for some 7 years, its most serious attack yet in Croatia occurred in 1959 on the 163-ha. 'Vijus' plantation near Brod. It multiplies very rapidly, producing three to four generations a year. In laboratory tests, it preferred 'Canadian' poplars to native species. As the former are now used on a large scale in plantations, damage from P. anastomosis can be expected to increase. [Cf. Jahn, Wettstein, and Sinreich, 1960, this subject classification.]

Miller, W. E. 1955. BIOLOGY OF ANACAMPSIS INNOCUELLA (ZELLER), A LEAF-ROLLER ON ASPEN. J. Econ. Ent. 48(5): 622-3. 5 refs.
Gives details of this leaf-eater's life history as observed on Populus grandidentata, other hosts already reported being P. wislizeni, P. tremuloides, and P. alba. A list of certain, probable and possible parasites is included.

Morris, R. C. 1956. LEAF BEETLE DAMAGES COTTONWOOD TREES IN DELTA. Inform. Sheet, Miss. Agric. Exp. Sta. No. 537, 2 pp.
An infestation of Chrysomela scripta in nurseries and a plantation is described. The beetles were readily controlled in the nursery by spraying with endrin or dieldrin.

Patocka, J. 1953. MURKY RODU SARROTHRIPUS—SKUDCI TOPOLU. [MOTHS OF THE GENUS SARROTHRIPUS—POPLAR PESTS.] Zool. Ent. Listy 2(2): 76-88. 9 refs. [Cz.russ.g.]
Illustrated description of two new species found in two places in Czechoslovakia, viz. Sarrothripus populana and S. cuneana.

———— 1954. HOUSENKY SKODICI NA LISTECH TOPOLU. [LARVAE THAT DAMAGE POPLAR LEAVES [IN CZECHOSLOVAKIA].] Prace Vyzkum. Ust. Lesn. CSR No. 5: 163-282. 36 refs. [Cz.russ.g.]

Schefer-Immel, V. 1957. AUFTRETEN EINIGER BISHER NOCH NICHT ODER NUR SELTEN AN PAPPEL UND DOUGLASIE BEOBACHTETER LEPIDOPTEREN. [LEPIDOPTERA NEWLY OR RARELY OBSERVED ON POPLAR AND DOUGLAS FIR.] Anz. Schadlingsk. 30(4): 57. [G.]
Acronycta leporina, Macrothylacia rubi and Biston stratarius on poplar and Tortrix viridana on Douglas fir.

———— 1959. EINIGE BEMERKUNGEN ZUR BIOLOGIE DES PAPPELTRIEBWICKLERS, SEMASIA ACERIANA DUP. [THE BIOLOGY OF S. ACERIANA.] Anz. Schadlingsk. 32(11): 166-9. 16 refs. [G.]
Observations in the Rhein-Main district during 1958-59 showed no influence of soils or age class upon susceptibility of poplars to attack by Semasia aceriana, but black and Lombardy poplars suffered more severely than Populus × canadensis. Observations are presented on biology and life history of the pest.

Schimitschek, E. 1955. ZUR KENNTNIS DES PAPPELSCHADLINGS PYGAERA ANASTOMOSIS L. (LEP.-FAM. NOTODONTIDAE). [P. ANASTOMOSIS, A PEST OF POPLAR.] Anz. Schadlingsk. 28(10): 153-6. 6 refs. [G.]
Notes on morphology, life history, and nature of damage.

Schnaiderowa, J. 1954. O ZWALCZANIU STONEK WYSTEPUJACYCH NA TOPOLACH. [CONTROL OF CHRYSOMELIDAE FOUND ON POPLARS.] Sylwan 98(4): 316-21. 12 refs. [Pol.pol.]

Templin, E. 1956. AUFTRETEN, BIONOMIE UND BEKAMPFUNG DES GROSSEN GABELSCHWANZES (DICRANURA VINULA L.) [OCCURRENCE, BIONOMICS AND CONTROL OF D. VINULA.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 16 (Beitr. Pappelforsch. No. 1): 102-30. 72 refs. [G.g.]

———— 1957. DIE ROTEN PAPPELBLATTKAFER (MELASOMA POPULI L. UND MELASOMA TREMULAE F.) [CHRYSOMELA POPULI AND C. TREMULAE.] Merkbl. Inst. Forstwiss. Tharandt (Abt. Forstschutz Tier. Schadl.) No. 13, 8 pp. [G.]
An illustrated description of the insects, their bionomics, habits, enemies, injuries, and control. Infestation, which may cause serious damage to young plants, is favored by hot, dry weather in late summer and spring. Chief enemies include pheasants and partridges, and the parasite Schizonotus sieboldi. Dusting or spraying with DDT in spring, or, if later treatments are necessary, combined DDT and BHC, are recommended.

Vasic, K. 1958. MALA TOPOLINA SOVICA (NYCTEOLA ASIATICA KRUL.) IZBILJNA STETOCINA TOPOLINIH KULTURA. [N. ASIATICA, A SERIOUS PEST OF POPLAR PLANTATIONS.] Topola, Beograd No. 6: 447-54. 6 refs. [Serb.f.]

[Yudelevich, M.] 1954. LA CUNCUNA DE LOS PINOS. [DIRPHYA ANPHIMONE.] Chile Maderero 4(7): 1, 3-4. [Span.]

416.12

Blankwaardt, H.F.H. 1955. DE POPULIERENSCHEUTBOORDER (EPINOTIA (GYPSONOMA) ACERIANA DUP.). [G. ACERIANA.] Ned. Boschb.-Tijdschr. 27(10): 266-73. 2 refs. [Du.e.] (Meded. Inst. Toegep. Biol. Onderz. Nat. No. 22. 1955.)

Kozlovsky, S. 1955. CONTRIBUTION A L'ETUDE MORPHOLOGIQUE ET BIOLOGIQUE DE PHYLLOCNISTIS SUFFUSELLA ZELL. ET LITHOCOLLETIS POPULIFOLIELLA TR. [MORPHOLOGICAL AND BIOLOGICAL STUDY OF P.

SUFFUSELLA AND L. POPULIFOLIELLA.] Ann. Ec. Eaux For. Nancy 14(2): 261-76. 26 refs. [F.]
A study of two poplar leaf-miners.

L., A. 1963. [CONTROL OF CRYPTORRHYNCHUS LAPATHI.] Monti e Boschi 14(2): 89-91. [It.]
Instructions for spraying with parathion in young poplar plantations.

Lindquist, O. H. 1963. THE COTTONWOOD LEAF MINER, LEUCOPTERA ALBELLA CHAM. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 19(1): 2.
L. albella is recorded, for the first time in Ontario, on Populus balsamifera, P. canadensis, P. deltoides, P. grandidentata, P. nigra, and P. tremuloides.

Martin, J. L. 1956. THE BIONOMICS OF THE ASPEN BLOTCH MINER, LITHOCOLLETIS SALICIFOLIOLLA CHAM. (LEPIDOPTERA: GRACILLARIIDAE). Canad. Ent. 88(4): 155-68. 10 refs. (Contr., Div. For. Biol. Dep. Agric. Can. No. 272.)

Savelj, M. 1961. TOPOLOV MOLJ (PHYLLOCNISTIS SUFFUSELLA ZELL.). [P. SUFFUSELLA.] Gozd. Vestn. 19(1/2): 21-3. 3 refs. [Sloven.]
Observations on attacks by this leaf-miner of poplar in Slovenia, its life history, the damage it causes, and control. [Cf. Schefer-Immel, below.]

Schefer-Immel,V. 1960. PHYLLOCNISTIS SUFFUSELLA Z. UND PHYTOMYZA (PHYTAGROMYZA) POPULI KLTB., ZWEI BLATTMINIERENDE PAPPELSCHADLINGE. [P. SUFFUSELLA AND P. POPULI, TWO LEAF-MINERS OF POPLAR.] Anz. Schadlingsk. 33(2): 22-4. 5 refs. [G.]
Presents observations on these leaf-miners, which were found causing considerable damage to poplars (chiefly Populus × 'canadensis') in the Rhein-Main area in the summers of 1958 and 1959.

[U.S.A.: South. For. Exp. Sta.] 1959. SYSTEMICS MAY HELP CONTROL COTTONWOOD BORER [GYPSONOMA HAIMBACHIANA]. Extr. from Rep. U. S. For. Serv. Sth. For. Exp. Sta. 1958: 48.
In a preliminary study, plants developed from cuttings that had been dipped in a carbon dust containing 44% thimet had an average of 1.1 borers per shoot and 0.8 per leader at the end of the first growing season, vs. 39.9 and 17.9 respectively in controls [cf. U.S.A.: Sth. For. Exp. Sta., 1958, P. deltoides to P. generosa, 453].

416.15

Aerts, R. 1963. [TRIALS IN THE CONTROL OF MELAMPSORA RUST OF POPLAR.] Agricultura, Louvain (Ser. 2) 11(2): 121-34. 6 refs. [F.f.du.e.g.]

Boyer, M. G. 1961. VARIABILITY AND HYPHAL ANASTOMOSES IN HOST-SPECIFIC FORMS OF MARSSONINA POPULI (LIB.) MAGN. Canad. J. Bot. 39(6): 1409-27. 20 refs. (Contr. For. Ent. Path. Br. Dep. For. Can. No. 763.)

Brandes, J. 1963. [ELECTRON MICROSCOPE STUDY OF A POPLAR VIRUS.] Phytopath. Z. 47(1): 84-9. 13 refs. [G.g.e.]
No reliable morphological differences could be found between a German and a Dutch isolate from infected leaves of Populus robusta and P. × canadensis 'Gelrica'.

Cash, E. K., and Waterman, A. M. 1957. A NEW SPECIES OF PLAGIOSTOMA ASSOCIATED WITH A LEAF DISEASE OF HYBRID ASPENS. Mycologia 49 (5): 756-60. 6 refs.
Discoloration of leaves in the progenies of intra- and interspecific crosses with Populus tremuloides was traced to a new species, Plagiostoma populi sp. nov., which is described.

Chiba, O., and Nobuno, Y. 1961. VARIETAL DIFFERENCES IN SUSCEPTIBILITY TO LEAF RUST— MELAMPSORA LARICI-POPULINA. Abstr. in Ann. Phytopath. Soc. Japan, Tokyo 26(2): 64. [Jap.]
From abstr. in Rev. Appl. Mycol. 41(3): 179-80. 1962.

———— and Zinno, Y. 1960. UREDOSPORES OF THE POPLAR LEAF RUST, MELAMPSORA LARICI-POPULINA KLEB., AS A SOURCE OF PRIMARY INFECTION. J. Jap. For. Soc. 42(11): 406-9. 6 refs. [E.e.jap.]

Donaubauer, E. 1963. [METHODS OF TESTING RUST SUSCEPTIBILITY IN POPLAR.] Cbl. Ges. Forstw. 80(3): 174-84. 10 refs. [G.]
Discusses various methods of rating described in the literature, and more particularly the method now employed in Austria— a further slight modification of Schreiner's method (as modified by van der Meiden [1961, this subject classification]).

Ende, G. van den. 1952. EEN BLADVLEKKENZIEKTE VOORKOMEND OP DE POPULIEREN VEROORZAAKT DOOR SEPTOTINIA POPULIPERDA WATERMAN AND CASH. [LEAF BLOTCH OF POPLARS CAUSED BY S. POPULIPERDA.] Tijdschr. PlZiekt. 58(2): 54-9. 3 refs. [Du.e.]
The leaf blotch was found in a nursery at Hoog Keppel in 1950; damage was slight. The fungus is described, and poplar species on which it has been found in the Netherlands are listed. [Cf. Waterman and Cash, 1950 Populus sp., 443.]

———— 1954. HET PARASITAIRE KARAKTER VAN SEPTOTINIA POPULIPERDA. [THE PARASITIC CHARACTER OF S. POPULIPERDA.] Tijdschr. PlZiekt. 60(6): 253-5. 4 refs. [Du.e.]
Cuttings of P. candicans, P. marilandica, and P. brabantica were sprayed with suspensions of the ascospores. Leaf blotches formed only when leaf injuries were already present. P. candicans proved the most susceptible species. Spraying the upper or lower leaf surface was equally effective. Germination of the ascospores was prevented by concentrations of Cu (Bordeaux mixture or $CuSO_4$) of 7-8 mg. Cu/litre.

Gremmen, J. 1954. OP POPULUS EN SALIX VOORKOMENDE MELAMPSORA-SOORTEN IN NEDERLAND. [MELAMPSORA SPP. FOUND ON POPULUS AND SALIX IN THE NETHERLANDS.] Tijdschr. PlZiekt. 60(6): 243-50. 5 refs. [Du.e.]

———— 1962. [MARSSONINA DISEASE OF POPLARS.] Ned. Boschb.-Tijdschr. 34(12): 428-32. 4 refs. [Du.e.e.]
Describes the perfect stage, identical with Drepanopeziza populorum, developed in culture from leaves infected with Marssonina sp. (probably M. populi). The ascospores are probably responsible for primary infection of nursery plants and older trees in spring. Further spread is by conidia.

Kang, K. -W. 1959. [STUDIES ON THE LEAF BLOTCH OF POPLAR CAUSED BY SEPTOTINIA POPULIPERDA.] Res. Rep. Inst. For. Genet., Suwon No. 1: 51-60. 25 refs. [Kor.kor.e.e.]
Discusses growth of the fungus in culture. Inoculations showed that of four species studied, Populus maximowiczii was most and P. monilifera least susceptible. Injured leaves were more susceptible than sound ones. No difference was found in size and number of stomata between the poplars tested, but epidermal tissue of P. nigra var. italica and P. monilifera (considered resistant) was thicker than in P. maximowiczii and P. koreana.

Magnani, G. 1961(1962). RUGGINE MEDITERRANEA DEL PIOPPO BIANCO DA MELAMPSORA PULCHERRIMA (BUB.) MAIRE. [M. PULCHERRIMA RUST OF POPULUS ALBA.] Pubbl. Cent. Sper. Agric. For., Roma 5: 221-36. 4 refs. [It.it.e.e.]
A description of M. pulcherrima, which causes a leaf rust in P. alba, its intermediate host being Mercurialis annua. Experimental inoculations on a number of other poplar species and hybrid clones showed low susceptibility in all; some infections were obtained on "I 154," "I 214," "I 455," P. nigra, P. × berelinensis, and P. yunnanensis.

———— 1963. [SEPTORIOSIS OF POPULUS NIGRA CAUSED BY SEPTORIA POPULI.] Pubbl. Cent. Sper. Agric. For., Roma 6: 5-26. 22 refs. [It.it.e.e.]
A fungus isolated from necrotic spots on leaves of P. nigra var. pyramidalis and P. × berolinensis in the nursery, and P. nigra in the field, was identified as S. populi Desm. Leaf inoculations on several poplar species and clones produced symptoms.

Meiden, H. A. van der. 1961. METHODEN TER BEOORDELING VAN DE AANTASTING VAN POPULIER DOOR ROEST. [METHOD FOR RATING RUST INFECTION ON POPLARS.] Ned. Boschb.-Tijdschr. 33(3): 77-80. 3 refs. [Du.e.]
Schreiner's rating for Melampsora infection [1959, this subject classification] is modified by the addition of a further class of infection, heavy necrosis and leaf-fall, with numerical values 125-375.

———— 1962. [MARSSONINA, A DANGEROUS POPLAR LEAF DISEASE.] Ned. Boschb.-Tijdschr. 34(7): 249-54. 5 refs. [Du.e.]
Describes the symptoms of the disease caused by one or more species of Marssonina, and discusses its exent in the Netherlands, and the effect of weather, the physiological condition of the tree

and the susceptibility of the clone, 'Serotina erecta' being the most and 'Robusta' the least susceptible of cultivars used in the Netherlands. Spraying with Cu solutions gives control in the nursery.

———— and Kolster, H. W. 1961. DE GEVOELIGHEID VAN EEN AANTAL POPULIEREKLONEN VOOR ROEST (MELAMPSORA LARICI-POPULINA). [THE SUSCEPTIBILITY OF A NUMBER OF POPLAR CLONES TO INFECTION BY M. LARICI-POPULINA.] Ned. Boschb.-Tijdschr. 33(3): 81-4. 2 refs. [Du.e.]

———— and Kolster, H. W. 1963. [THE SUSCEPTIBILITY OF A NUMBER OF POPLAR CLONES TO INFECTION BY MELAMPSORA LARICI-POPULINA.] Ned. Boschb.-Tijdschr. 35(10): 413-5. 2 refs. [Du.e.]
Of 100 clones assessed, Eckhof, I 154, I 455, I 63/51, I 74/51, I 77/51 and Virginiana de Frignicourt were the most resistant. Six others were sufficiently resistant and 12 clones proved very susceptible to leaf-cast caused by Marssonina.

Nohara Y., Kodama, T., and Aoyama, Y. 1961. [STUDIES ON THE CONTROL OF POPLAR LEAF RUST. (I) CONTROL TESTS BY FUNGICIDES.] Bull. For. Exp. Sta., Meguro, Tokyo No. 130: 45-50. 2 refs. [Jap.jap.e.]

———— Kodama. T., and Aoyama, Y. 1962. [STUDIES ON CONTROL OF POPLAR LEAF RUST. (II) SPRAYING WITH DITHANE AND NARA-MYCIN.] Bull. For. Exp. Sta., Meguro, Tokyo No. 139: 177-80. 3 refs. [Jap.jap.e.]
Reports further tests with (a) Dithane (1/400 in water) and (b) Nara-mycin (1/2500 in water), using seedlings of a susceptible clone P. × 'Peace.' Dithane was sprayed 5, 10, 15, and 20 times in the growing season, the last being the most effective. A mixture of (a) and (b), however, proved best of all.

Regler, W. 1957. DER KIEFERNDREHROST (MELAMPSORA PINITORQUA), EINE WIRTSCHAFTLICH WICHTIGE INFEKTIONS-KRANKHEIT DER GATTUNG PINUS. [M. PINITORQUA, A PINE DISEASE OF ECONOMIC IMPORTANCE.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 27 (Beitr. Pappelforsch. No. 2): 205-34. 51 refs. [G.g.]

Saric, A., and Milatovic, I. 1960. POKUS SUZBIJANJA RDE TOPOLA U SUMSKOM RASADNIKU BANOVA JARUGA. [A TRIAL OF POPLAR RUST CONTROL IN THE BANOVA JARUGA FOREST NURSERY.] Sum. List 84 (9/10): 290-1. 6 refs. [Croat.e.]

Schmidle, A. 1953. UBER EINE BLATTKRANKHEIT DER PAPPEL. [A LEAF DISEASE OF POPLAR.] Nachrichtenblatt des Deutschen Pflanzenschutzdienstes, Braunschweig 5(6): 81-3. 7 refs. [G.]
Describes a disease observed on Populus marilandica, P. vernirubens, and P. robusta in the Helmstedt district and its pathogen. The fungus is identified with Septotinia populiperda Waterman and Cash, having a conidial form Septotis populiperda (syn. Septoglosum populiperdum Moesz et Smarods). No conclusion is reached on the question whether this fungus is identical, despite difference in symptoms, with Septoglosum populiperdum Johannes.

Schreiner, E. J. 1959. RATING POPLARS FOR MELAMPSORA LEAF RUST INFECTION. U. S. For. Serv. Ntheast. For. Exp. Sta. Res. Note No. 90, 3 pp.
Describes a system successfully used by the author to estimate the pathological effect of the rust on hybrid poplars rating them on a numerical scale from 1 to 100 according to degree of infection on leaves and percent of leaves affected.

Schwenke, H. J. 1960. UNTERSUCHUNGEN UBER DEN PARASITISMUS VON SEPTOTIS POPULIPERDA WATERMAN ET CASH. [STUDIES ON THE PARASITIC ACTION OF S. POPULIPERDA.] Phytopath. Z. 38(1): 69-92. 26 refs. [G.g.e.] [Cf. Schwenke, 1958, Populus sp., 416.4.]

416.16

Gambogi, P., and Verona, O. 1958. PRESENZA IN ITALIA DI PESTALOTIA POPULI-NIGRAE SAWODA ET K. ITO, CAUSA DI UNA MALATTIA ('SHOOT BLIGHT') DEL PIOPPO. [THE OCCURRENCE IN ITALY OF P. POPULI-NIGRAE, CAUSE OF SHOOT BLIGHT OF POPLAR.] Ann. Sper. Agr. (n.s.) 12(4): suppl. pp. i-iii. 2 refs. [It.it.e.]
The fungus described by the first author as a new species and named Pestalotia lignorum [cf. Gambogi, 1957, P. tremula, 844.1] has now been identified with P. populi-nigrae [cf. Ito, 1950, below].

Gremmen, J. 1962. [POPLAR SHOOT DIE-BACK CAUSED BY SEPTOTINIA PODOPHYLLINA.] Ned. Boschb.-Tijdschr. 34(11): 416-9. 5 refs. [Du.e.]
Describes the symptoms of attack by the fungus, which is common on species and cultivars in the nurseries at Wageningen but has not been observed on older trees. Successful attack occurs only after damage to leaves, e.g., by insects, and control both of the latter and of ascospore discharge, and the use of resistant species and cultivars are recommended.

Ito, K. 1950. CONTRIBUTIONS TO THE DISEASES OF POPLARS IN JAPAN. I. SHOOT BLIGHT OF POPLARS CAUSED BY A NEW SPECIES OF PESTALOTIA. Bull. For. Exp. Sta. Meguro, Tokyo No. 45: 135-46. 27 refs. [E.e.jap.]

Moriondo, F. 1961. ALTERAZIONI SU PIANTE DI PIOPPO IN SEGUITO A CRISI DI ATTECHIMENTO. II. IDENTIFICAZIONE DI UN NUOVO PARASSITA PIOPPICOLO. [A DIEBACK OF POPLARS FOLLOWING TRANSPLANTATION SHOCK. II. IDENTIFICATION OF A NEW POPLAR PATHOGEN.] Ann. Accad. Ital. Sci. For. 10: 135-52. 27 refs. [It.f.]
The fungus already recorded as a pathogen of hybrid poplars after transplanting has been identified as Phomopsis tirrenica sp. nov. (possibly identical with Fusicoccum populinum). [Cf. Moriondo, 1955, Populus sp., 48.]

416.2

Templin, E. 1960. ANWENDUNGSMOGLICHKEITEN VON TIEFENWIRKENDEN INSEKTIZIDEN UND SYSTEMISCHEN MITTELN GEGEN BLATT- UND TRIEBMINIERENDE INSEKTEN IN DER FORSTWIRTSCHAFT. [THE POTENTIAL USES OF INSECTICIDES WITH DEPTH ACTION AND SYSTEMICS IN THE CONTROL OF LEAF- AND SHOOT-MINING FOREST PESTS.] Proc., 4th Int. Congr. Crop Protection, Braunschweig, Vol. 2: 1321-7. 17 refs. [G.]

416.3

Allegri. 1959. NOTE PRELIMINARIE SUR LES CAPNODES DES PEUPLIERS. [PROVISIONAL NOTE ON CAPNODIS SPECIES ON POPLARS.] [Docum.] Int. Poplar Comm. 1st Sess. Wkg. Party on Insects, Rome 1959 No. FAO/CIP/IN/4 (Annexe 1), 11 pp. [F.]

Benben, K. 1954. NOWE CHOROBY TOPOLI. [NEW DISEASES OF POPLARS.] Sylwan 98 (2): 91-5. 7 refs. [Pol.]

Harper, A. M. 1959. GALL APHIDS ON POPLAR IN ALBERTA. II. PERIODS OF EMERGENCE FROM GALLS, REPRODUCTIVE CAPACITIES, AND PREDATORS OF APHIDS IN GALLS. Canad. Ent. 91(11): 680-5. 9 refs.

Wong, H. R., McLeod, B. B., and Drovin, J. A. 1963. SAPERDA CALCARATA SAY IN THE ROOT COLLAR OF POPLARS. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 19(5): 2. 3 refs.
The Saperda sp. found tunneling in the root collar of Populus tremuloides and P. balsamifera in Manitoba and Saskatchewan [see F.A. 23, No. 914] has now been definitely identified as S. calcarata. Further notes are given on its life history.

416.3/5

Good, H. M., and Nelson, J. I. 1962. FOMES IGNIARIUS VAR. POPULINUS. FUNGI ASSOCIATED WITH FOMES IGNIARIUS VAR. POPULINUS IN LIVING POPLAR TREES AND THEIR PROBABLE SIGNIFICANCE IN DECAY. Canad. J. Bot. 40(4): 615-24. 11 refs.

Lohwag, K. 1959. HOLZFAULEN AN PAPPELHOLZ. [WOOD-ROTTING FUNGI ON POPLAR.] Istanbul Univ. Orm. Fak. Derg. 9A(1): 1-10. 1 ref. [G.turk.g.turk.]
Discusses damage by Fomes igniarius on standing trees, and by Stereum purpureum, Polystictus hirsutus and Schizophyllum commune on logs in a storage depot. Preventive and control measures are also discussed.

Thomas, G. P., Etheridge, D. E., and Paul, G. 1960. FUNGI AND DECAY IN ASPEN AND BALSAM POPLAR IN THE BOREAL FOREST REGION, ALBERTA. Canad. J. Bot. 38(4): 459-66. 7 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 620.)

416.4

Allen, A. A. 1958. TRYPOPHLOEUS ASPERATUS GYLL. (COL., SCOLYTIDAE) IN KENT AND DORSET. Ent. Mon. Mag. 94(1132): 216.
Two records, believed to be the first for the two counties, of the finding of this rare Populus-feeding bark beetle.

Arnold, R. H., and Russell, R. C. 1960. CUCURBITARIA STAPHULA ON POPULUS AND ITS ASSOCIATION WITH MACROPHOMA TUMEFACIENS. Mycologia 52(3): 499-512. 20 refs. (Contr. Plant Res. Inst., Res. Br., Dep. Agric., Can. No. 94.)

Baldacci, E., Ciferri, R., Orsenigo, M., and Soaranuzzi, G. 1950. OSSERVAZIONI SUL "CANCRO BATTERICO" DEL PIOPPO IN LOMBARDIA. [OBSERVATIONS ON BACTERIAL CANKER OF POPLAR IN ITALY.] Notiz. Malatt, Piante No. 9: 15-25. 10 refs. [It.]

Berbee, J. G. 1962. DEVELOPMENT OF FUSARIUM CANKER OF BLACK POPLARS. Abstr. in Phytopathology 52(8): 724.

Bloomberg, W. J. 1959. SOME PHYSIOLOGICAL AND ANATOMICAL CHARACTERISTICS OF POPULUS SPP. AS RELATED TO INFECTION BY CYTOSPORA CHRYSOSPERMA FR. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 15(2): 3.

———— 1962. CYTOSPORA CANKER ON POPLAR. [A] FACTORS INFLUENCING THE DEVELOPMENT OF THE DISEASE. [B] THE MOISTURE RELATIONS AND ANATOMY OF THE HOST. Canad. J. Bot. 40(10): 1271-92. 27 refs. (Contr. For. Ent. Path. Br. Dep. For. Can. Nos. 828 and 841.)

———— and Farris, S. H. 1963. CYTOSPORA CANKER OF POPLARS: BARK WOUNDING IN RELATION TO CANKER DEVELOPMENT. Canad. J. Bot. 41: 303-10. 13 refs. (Contr. For. Ent. Path. Br. Dep. For. Can. No. 882.)

Bohm, A. 1957. DOTHICHIZA POPULEA SACC. ET BR. KAO UZROCNIK PROPADANJA TOPOLA S POSEBNIM OSVRTOM NA JAKU ZAVAZU U PROLJECE 1956 U HRVATSKOJ. [D. POPULEA AS A CAUSE OF POPLAR MORTALITY, WITH PARTICULAR REFERENCE TO THE SPRING 1956 OUTBREAK IN CROATIA.] Sum. List 81(1/2): 13-30. 22 refs. [Croat.e.]

Brink, G. 1949. VERSLAG VAN HET ONDERZOEK NAAR DE POPULIERENKANKER IN 1947. [REPORT ON INVESTIGATIONS IN 1947 ON BACTERIAL CANKER OF POPLARS.] Mededelingen van de Nederlandsche Heidemaatschappij, Arnhem No. 8, 10 pp. [Du.e.]
Resistance tests were continued, but the warm, dry summer appeared to be unfavorable for the formation of canker. Many species of bacteria, one of which had some effect on Populus candicans but was not identical with Pseudomonas rimaefaciens already isolated, and some fungi were isolated from slime and diseased tissue. [Cf. Pelkwijk and Brink, 1947?, Populus sp., 443.]

———— and Ende, G. van den. 1951. VERSLAG VAN HET ONDERZOEK NAAR DE POPULIERENKANKER IN 1948 EN 1949. [REPORT ON INVESTIGATIONS IN 1948 AND 1949 ON BACTERIAL CANKER OF POPLARS.] Mededelingen van de Nederlandsche Heidemaatschappij, Arnhem No. 13, 15 pp. [Du.e.]

Butin, H. 1957. DIE BLATT- UND RINDENBEWOHNENDEN PILZE DER PAPPEL UNTER BESENDERER BERUCKSICHTIGUNG DER KRANKHEITSERREGER. [THE LEAF- AND BARK-INHABITING FUNGI OF POPLARS, WITH SPECIAL REFERENCE TO PATHOGENIC SPECIES.] Mitt. Biol. Bundesanst. Land- u. Forstw., Berlin No. 91, 64 pp. 20 refs. [G.]
Lists 94 leaf- and 51 bark-inhabiting species, their synonyms, morphology, injuries, and hosts (including differential susceptibility). A preliminary chapter presents tabulated data on the frequency and distribution over the stem, of 20 species found on 5-year-old trees of Populus "canadensis" cv. robusta which had been killed by Dothichiza populea but were still standing.

———— 1958. UNTERSUCHUNGEN UBER EIN TOXIN IN KULTURFILTRATEN VON DOTHICHIZA POPULEA SACC. ET BR. [STUDIES ON A TOXIN IN CULTURE FILTRATES OF D. POPULEA.] Phytopath. Z. 33(3): 135-46. 16 refs. [G.g.e.]

Cumaevskaja, M. A. 1957. BAKTERIAL'NYJ RAK TOPOLJA. [BACTERIAL CANKER OF POPLAR.] Dokl. Vsesojuz. Akad. Sel.-Hoz. Nauk. Lenina 1957(3): 40-4. 7 refs. [Russ.]

Donaubauer, E. [1957.] ZUR KENNTNIS VON CHONDROPLEA POPULEA (SACC.) KLEB. (SYN: DOTHICHIZA POPULEA SACC. ET BRIARD), DEM ERREGER DES PAPPELRINDENTODES. [OUR KNOWLEDGE OF D. POPULEA.] Gemeinschaft zur Forderung der Pappelkultur in Osterreich. Wien. 14 pp. 15 refs. [G.]
Describes, chiefly for the practical forester, the symptoms and course of the disease, conditions favoring infection, prophylaxis (silvicultural, chemical and by resistance breeding) and control (mechanical) and gives data on the extent of the epidemic in Austria.

Eichbaum, K. 1956. ZUM PAPPELRINDENTOD—DOTHICHIZA POPULEA. [NOTES ON D. POPULEA.] Allg. Forstzeitschr. 11(27/28): 352-4. [G.]
A discussion of symptoms, secondary injuries caused, conditions favoring infestation, practical experiences, etc.

Eimern, J. van. 1956. DIE WITTERUNG IM WINTER 1954-55 UND IM FRUHJAHR 1955 UND IHRE MOGLICHE BEDEUTUNG FUR DEN RINDEN TOD DER PAPPEL. [THE WEATHER OF THE WINTER 1954-55 AND SPRING 1955, AND ITS POSSIBLE SIGNIFICANCE IN CONNECTION WITH THE DOTHICHIZA POPULEA EPIDEMIC.] Forstarchiv 27(2): 30-4. 4 refs. [G.g.]

———— 1956. KANN DIE WITTERUNG IM WINTER 1954-55 UND IM FRUHJAHR 1955 FUR DEN RINDENTOD DER PAPPEL VERANTWORTLICH SEIN? [CAN THE WEATHER IN WINTER 1954-55 AND SPRING 1955 BE RESPONSIBLE FOR THE DOTHICHIZA POPULEA DISEASE OF POPLARS?] Holzzucht, Reinbek 10(2): 10-3. 4 refs. [G.]

Ende, G. van den. 1955. VERSLAG VAN HET ONDERZOEK NAAR DE POPULIERENKANKER IN 1952 EN 1953, VEROORZAAKT DOOR PSEUDOMONAS SYRINGAE V. HALL. F. SP. POPULEA SABET. [REPORT ON INVESTIGATIONS IN 1952 AND 1953 ON CANKER OF POPLARS CAUSED BY P. SYRINGAE F. SP. POPULEA.] Mededelingen van de Nederlandsche Heidemaatschappij, Arnhem No. 21, 19 pp. [Du.du.e.]

———— 1957. HET ONDERZOEK OVER DE POPULIERENKANKER VEROORZAAKT DOOR PSEUDOMONAS SYRINGAE V. HALL F. SP. POPULEA SABET. [STUDIES ON CANKER OF POPLARS CAUSED BY P. SYRINGAE F. SP. POPULEA.] Meded. van de LandbHogesch. en de Opzoekingsstations van de Staat te Gent 22(3): 527-34. 10 refs. [Du.du.e.] (Negende Jaarlijks Symposium over Phytopharmacie, Gent 1957.)
Surveys research by the author [above reference] and others since 1937.

Gyorfi, J. 1954. A NYARKEREGHALAL ES A NYARFATAK MAGYARORSZAGI KAROSITASA. [DAMAGE TO POPLARS FROM BARK DECAY AND CANKER IN HUNGARY.] Erdesz. Kutatas., Budapest No. 3: 105-14. 19 refs. [Hu.e.g.]

Herpka, I. 1956. POJAVA UGIBANJA KORE NA TOPOLAMA (PRETHODNI IZVJESTAJ). [BARK DISEASE OF POPLARS (PRELIMINARY COMMUNICATION).] Sum. List 80(9/10): 282-99. 14 refs. [Croat. croat.]
Reports and describes in some detail cases of bark disease (not the first time reported) caused by the fungus Dothichiza populea in nurseries, clones, young and old plantations, and old poplar stands in Croatia. Populus candicans was found to be relatively the most resistant species.

———— 1960. NOVA POJAVA ODUMIRANJA KORE NA TOPOLAMA. [NEW OCCURRENCE OF BARK NECROSIS ON POPLARS.] Topola, Beograd No. 15: 19-21. [Serb.f.]
The disease, noted on young poplars in nurseries in N. Yugoslavia since 1956, is always found on shaded plants in excessively wet soils, and is believed to be a physiological disorder.

Hubbes, M. 1959. UNTERSUCHUNGEN UBER DEN ERREGER DES RINDENBRANDES DER PAPPEL. [EXPERIMENTS ON DOTHICHIZA POPULEA.] Forstarchiv 30(2): 25-9. [G.]

———— 1959. UNTERSUCHUNGEN UBER DOTHICHIZA POPULEA SACC. ET BRIARD, DEN ERREGER DES RINDENBRANDES DER PAPPEL. [EXPERIMENTS ON D. POPULEA.] Phytopath. Z. 35(1): 58-96. 83 refs. [G.g.e.]

Joachim, H. -F. 1958. UBER DEN BRAUNFLECKENGRIND. [THE POPLAR BARK DISEASE 'BRAUNFLECKENGRIND'.] Allg. Forstzeitschr. 13(38): 548-51. 10 refs. [G.g.]

———— 1960. UBER HAGELSCHADEN AN PAPPELN. [HAIL DAMAGE TO POPLARS.] Arch. Forstw. 9(3): 259-65. 2 refs. [G.russ.e.]

Kalandra, A. 1961. ['BRAUNFLECKENGRIND' OF POPLARS IN BOHEMIA.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(6): 591-6. 19 refs. [Cz.cz.russ.g.]

Discusses its distribution in Czechoslovakia, species affected and associated pests and diseases.

———— 1961. [POPLAR CANKER.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(7): 599-604. 35 refs. [Cz.cz.russ.g.]
Discusses the cankers caused by Pseudomonas rimefaciens and Nectria galligena and their occurrence, so far on a relatively small scale, in Czechoslovakia.

Kochman, J. 1957(1958). ZGORZEL KORY TOPOLI POWODOWANA PRZEZ GRZYB VALSA SORDIDA NITSCHKE I WARUNKI JEJ WYSTEPOWANIA W POLSCE. [BARK NECROSIS OF POPLARS CAUSED BY THE FUNGUS V. SORDIDA, AND ITS OCCURRENCE IN POLAND.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 12: 67-103. 30 refs. [Pol.russ.g.]

Krstic, M. 1958. "KRASTAVOST" TOPOLA, JEDNA NEZABELEZENA FITOPATOLOSKA POJAVA KOD NAS. ["SCABBINESS" OF POPLAR, NOT HITHERTO REPORTED IN YUGOSLAVIA.] Topola, Beograd No. 8: 667-72. 6 refs. [Serb.f.]
Describes the bark disease called in Germany 'Braunfleckengrind' [cf. F.A. 19, Nos. 2101, 3105] and reports the locations in Serbia where it was found by the author and where P. × serotina wood was most affected, P. × robusta and P. × marilandica wood less so.

Leontovyc, R. 1960. PRISPEVOK K POZNANIU DOTHICHIZA POPULEA SACC. ET BRIARD NA SLOVENSKU. I. ROZSIRENIE A VYVOJOVE CYKLY SO SYMPTOMATIKOU. [D. POPULEA IN SLOVAKIA. I. DISTRIBUTION, DEVELOPMENT CYCLES AND SYMPTOMS.] Ved. Prace Vyskum. Ust. Lesn. Hosp. Bansk. Stiav. No. 1: 233-56. 11 refs. [Slovak.slovak. russ.g.]

Magnani, G. 1958. LA DIFFUSIONE E L'IMPORTANZA DELLA CYTOSPORA SUI PIOPPI. [OCCURRENCE AND IMPORTANCE OF CYTOSPORA ON POPLARS.] Ital. For. Mont. 13(1): 23-8. 21 refs. [It.f.]

———— 1959(1960). RICERCHE SULLA NECROSI CORTICALE DEL PIOPPO DA DOTHICHIZA POPULEA SACC. ET BRIARD. [BARK NECROSIS OF POPLARS CAUSED BY D. POPULEA.] Pubbl. Cent. Sper. Agric. For., Roma No. 3: 77-126. 47 refs. [It.it.e.e.]

Meiden, H. A. van der. 1961. PLANTAFSTAND EN BASTVLEKKENZIEKTE BIJ POPULIER. [PLANT SPACING AND "BARK SCAB DISEASE" OF POPLARS.] Ned. Boschb.-Tijdschr. 33(7): 206-10. 4 refs. [Du.e.g.e.g.]

Muller-Stoll, W. R., and Hartmann, U. 1950. UBER DEN CYTOSPORA-KREBS DER PAPPEL (VALGA SORDIDA NITSCHKE) UND DIE BODINGUNGEN FUR CINE PARASITARE AUSBREITUNG. [THE CYTOSPORA CANKER OF POPLAR (V. SORDIDA) AND CONDITIONS FOR ITS PARASITIC SPREAD.] Phytopath. Z. 16(4): 445-78. 38 refs. [G.g.]
Describes the species and symptoms of its attack on poplar, and discusses its distribution, conditions favoring parasitic attack, and control methods by ensuring adequate water supply especially to young trees, avoiding damage to the trees and removing all infested material.

Nather, H. 1954. ZUM MASSENAUFTRETEN VON "RINDENTOD" AN PAPPELJUNGKULTUREN IM JAHRE 1953. [THE MASS OCCURRENCE OF BARK DYING IN YOUNG POPLAR PLANTATIONS IN 1953.] Allg. Forstztg. 65(1/2): 9-10. [G.]
Cytospora chrysosperma and Dothichiza populea did great damage to mostly bottom-land plantations in the exceptionally hot and dry summer of 1953. Populus deltoides var. missouriensis frequently showed infection at the base of last year's terminal shoot, P. 'carolina' frequently at the base of the stem, where the wounds were more readily concluded. Large leaved varieties, which frequently lost their leaves that summer, were generally more susceptible. Mistakes (drying out) in planting, dryness of site, injuries, and damage by fertilizers are discussed.

Oldenkamp, L. 1961. DE BASTVLEKKENZIEKTE. [THE 'BARK SCAB DISEASE'.] Ned. Boschb.-Tijdschr. 33(7): 203-5. 12 refs. [Du.]
Reviews literature, mainly European, on its occurrence on hardwoods, especially poplars, concluding that fungi and bacteria and possibly a virus may be considered primary causative agents, and that abiotic factors (water relations and perhaps frost damage and insolation) may be important. [Cf. Joachim, 1958, and Rambelli, 1959, this subject classification.]

Peno, M. 1960. PSEUDOMONAS SP. NA TOPOLI. [PSEUDOMONAS SP. ON POPLAR.] Topola, Beograd No. 17/18: 17-9. [Serb.f.]
Studies on Pseudomonas infections of Populus × robusta and P. serotina at Mol suggest that Pseudomonas is in symbiosis with other bacteria favorable to its development, forming a tumor-like canker. The tree's general development is not greatly affected (though the volume of damage has not been calculated), but the wounds admit secondary pests.

Petrovic, N. 1958. STETNI GLODARI U TOPOLICIMA. [RODENTS CAUSING DAMAGE TO POPLAR STANDS.] Topola, Beograd No. 6: 469-75. 8 refs. [Serb.]
Rodents destructive to the bark of poplar trees in the Danube and Tisa valleys are Arvicola terrestris and Microtus arvalis. A rapid increase in their population has occurred recently, as natural enemies are few. The damage is caused primarily after floods and during winter when food is scarce. Suggestions are made for control by poison bait.

Rambelli, A. 1959. INTORNO AD UNA GRAVE FISIOPATIA DEL PIOPPO. [A SERIOUS DISORDER OF POPLAR.] Monti e Boschi 10(1): 25-9. [It.f.e.]
Gives a detailed description, with illustrations of the lesions occurring in bacterial canker of poplar, now very widespread in Italy, and briefly discusses possible predisposing factors.

———— 1959. LA COSIDDETTA BATTERIOSI DEL PIOPPO. [THE 'BACTERIAL DISEASE' OF POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 2: 233-42. 8 refs. [It.it.e.e.]
Discusses factors possibly involved in the disorder, e.g., insolation; root competition; pedological and hydrological disequilibrium; and over-wide spacing in plantations on fresh soils. [Cf. Vivani, 1959, P. canadensis to P. davidiana, 443.3.]

———— 1963. [FURTHER INVESTIGATIONS ON THE SO-CALLED BACTERIAL DISEASE OF POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 6: 95-115. 3 refs. [It.it.e.]
Observations on 18 plantations of hybrid poplars confirm the nonbiotic nature of the disorder, believed to be due to root competition in soils with a gravel subsoil or rapid drainage. The influence of spacing on the severity of the disorder is stressed.

Rettelbach, B. 1953. WUHLMAUSBEKAMPFUNG MIT DER HERZSCHEN PATRONE. [CONTROL OF ARVICOLA TERRESTRIS WITH THE HERZ FUMIGATING CARTRIDGE.] Forst u. Holz 8(21): 306-8. [G.]

Ride, M. 1958. SUR L'ETIOLOGIE DU CHANCRE SUINTANT DU PEUPLIER. [THE ETIOLOGY OF THE BLEEDING CANKER OF POPLAR.] C.R. Acad. Sci., Paris 246(19): 2795-8. 6 refs. [F.]
Cultures of Aplanobacterium populi sp. nov., isolated from cankers of Populus × euramericana and P. tremula, produced the characteristic cankers when inoculated into the trees at intervals over 2 years. Its characteristics in culture are described.

Rogers, J. D. 1963. HYPOXYLON CANKER OF ASPEN. I. SCREENING FOR DISEASE RESISTANCE. II. DEVELOPMENTAL MORPHOLOGY AND CYTOLOGY OF HYPOXYLON PRUINATUM. Abstr. of thesis, in Dissert. Abstr. 23(11): 4061-2. [Univ. Wis.]
Includes data on six inoculation methods, and on the relative resistance of a number of poplar species and hybrids.

Sabet, K. A. 1952. A DISCUSSION OF THE CAUSE OF THE BACTERIAL DIE-BACK AND CANKER DISEASE OF POPLAR. Ned. Boschb.-Tijdschr. 24(5): 126-9. 7 refs. [E.du.]
Briefly describes studies leading to the conclusion that Pseudomonas syringae f. sp. populae is responsible for bacterial dieback and canker of poplar. Details of the studies will be published elsewhere.

———— 1953. STUDIES IN THE BACTERIAL DIE-BACK AND CANKER DISEASE OF POPLAR. II. THE RELATION BETWEEN THE BACTERIAL SLIME AND THE CAUSAL ORGANISM. Proc. Soc. for Applied Bacteriology, Reading 16(1): 45-55. 8 refs.

———— 1953. STUDIES IN THE BACTERIAL DIE-BACK AND CANKER DISEASE OF POPLAR. III. FREEZING IN RELATION TO THE DISEASE. Ann. Appl. Biol. 40(4): 645-50. 9 refs.

———— and Dowson, W. J. 1952. STUDIES IN THE BACTERIAL DIE-BACK AND CANKER DISEASE OF POPLAR. I. THE DISEASE AND ITS CAUSE. Ann. Appl. Biol. 39(4): 609-16. 11 refs.

Sanz Pastor, J. M. 1956. RESULTATS DE L'ENQUETE SUR DOTHICHIZA POPULEA. REPONSE AU QUESTIONNAIRE FAO-CIP/MAL/1 SUR

LE DOTHICHIZA POPULEA SACC. ET BRIARD (=CONDROPLEA POPULEA KLEB.) ET RENSEIGNEMENTS SUR QUELQUES AUTRES CHANCRES DU PEUPLIER DUS A DES CHAMPIGNONS OU A DES BACTERIES. [RESULTS OF THE INQUIRY ON D. POPULEA. SPAN. REPLY TO THE QUESTIONNAIRE FAO/CIP/MAL/1 ON D. POPULEA AND INFORMATION ON SOME OTHER CANKERS CAUSED BY FUNGI OR BACTERIA.] [Pap.] Int. Poplar Comm. No. FAO/CIP/MAL/2-C, 1 p. [F.]

Savelj, M. 1957. TOPOLOV RAK (VALSA SORDIDA NITSCH.). [POPLAR CANKER CAUSED BY V. SORDIDA.] Gozd. Vestn. 15(2/3): 81-7. 4 refs. [Sloven.]
Investigations carried out in Slovenia in 1955-56 seem to show that the poplars affected with this canker were weakened as a result of (1) wrong planting methods, (2) unfavorable water regime, and (3) extremes of temperature, these factors having lessened the natural resistance of the trees.

Schmidle, A. 1953. DIE CYTOSPORA-KRANKHEIT DER PAPPEL UND DIE BEDINGUNGEN FUR IHR AUFTRETEN. [THE CYTOSPORA DISEASE OF POPLAR AND CONDITIONS FAVORING ITS OCCURRENCE.] Phytopath. Z. 21(1): 83-96. 34 refs. [G.]

———— 1953. ZUR KENNTNIS DER BIOLOGIE UND DER PATHOGENITAT VON DOTHICHIZA POPULEA SACC. ET BRIARD, DEM ERREGER EINES RINDENBRANDES DER PAPPEL. [THE BIOLOGY AND PATHOGENIEITY OF D. POPULEA, THE CAUSE OF A BARK-SCORCH OF POPLAR.] Phytopath. Z. 21(2): 189-209. 52 refs. [G.g.]

Schonhar, S. 1953. UNTERSUCHUNGEN UBER DIE BIOLOGIE VON DOTHICHIZA POPULEA (ERREGER DES PAPPELRINDENTODOS). [THE BIOLOGY OF D. POPULEA, CAUSE OF POPLAR BARK DISEASE.] Forstwiss. Cbl. 72(11/12): 358-68. 6 refs. [G.]

———— 1956. BRAUNFLECKEN GRIND UND RINDENTOD DER PAPPEL. ["BRAUNFLECKENGRIND" AND THE POPLAR DISEASE CAUSED BY DOTHICHIZA POPULEA.] Allg. Forstzeitschr. 11(27/28): 349-52. 5 refs. [G.g.]

———— 1957. EIN BEITRAG ZUR FRAGE DER ANFALLIGKEIT VERSCHIEDENER PAPPELARTEN UND PAPPELSORTEN GEGEN DOTHICHIZA POPULEA. [THE SUSCEPTIBILITY OF VARIOUS POPLARS TO D. POPULEA.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 6: 59-62. 4 refs. [G.]

———— 1960. UNTERSUCHUNGEN UBER DIE ANFALLIGKEIT VERSCHIEDENER PAPPELSORTEN GEGEN DOTHICHIZA POPULEA. [THE SUSCEPTIBILITY OF VARIOUS POPLAR VARIETIES TO D. POPULEA.] Allg. Forst- u. Jagdztg. 131(11): 259-61. 7 refs. [G.g.e.]

———— 1963. [A FURTHER CONTRIBUTION TO THE SUSCEPTIBILITY OF VARIOUS POPLAR VARIETIES TO DOTHICHIZA POPULEA.] Allg. Forst- u. Jagdztg. 134(2): 57-60. 3 refs. [G.g.e.]

Schwenke, H. J. 1958. BEITRAGE ZUR BIOLOGIE UND ZUM PARASITISMUS VON SEPTOTIS POPULIPERDA WATERMAN ET CASH. [ON THE BIOLOGY AND PARASITIC ACTION OF S. POPULIPERDA.] Abstr. of thesis, in Forsch. u. Berat. (Forstw.) Landesaussch. Landw. Forsch. Landes Nordrhein-Westfalen No. 3: 102-6. [G.]

Shea, K. R. 1963. INDUCTION OF HYPOXYLON CANKERS IN ASPENS BY ARTIFICIAL INOCULATION. For. Sci. 9(1): 2-7. 12 refs.
An extended account, reporting no success with spores and highly significant differences in percent infection with inocula from various culture media and between plots. The covering or not covering of the wound made no difference.

———— and Kuntz, J. E. 1956. INOCULATION OF ASPENS WITH HYPOXYLON PRUINATUM (KL.) CKE. For. Res. Note Wis. Coll. Agric. No. 27, 2 pp.
A study was made in order to develop a satisfactory method for the artificial infection of poplars when testing susceptibility in the course of breeding experiments. Populus tremuloides and P. grandidentata, 2-4 in. in diam., were used. Best results (82% infections) were obtained by inserting mycelium grown on oat-wheat substrata into a slit in the bark and covering the wound with adhesive tape.

Stefanov, D., Zasev, B., and Canova, P. 1961. KAFJAVO SLIZOTECENIE I NJAKOI GABI PO STABLATA I KLONITE NA TOPOLITE V NR BALGARIJA. ["BRAUNFLECKENGRIND," AND SOME FUNGI ON STEMS AND BRANCHES OF POPLARS IN BULGARIA.] Nauc. Trud. Lesoteh. Inst., Sofija 9: 143-56. 13 refs. [Bulg.g.]

Szilagyi, L. 1961. A NYARFARAK ELLENI VEDEKEZES LEHETOSEGEI. [CONTROL OF POPLAR CANKER.] Erdo 10(10): 417-23. [Hu.russ.g.]

Szontagh, P. 1961. A TARKA EGERORMANYOS (CRYPTORRHYNCHUS LAPATHI L.) MINT NEMESNYAR ANYATELEPEINK KAROSITOJA. [THE WILLOW BORER AS A PEST OF POPLAR NURSERIES.] Erdo 10(7): 303-7. [Hu.russ.g.]

Taris, B. 1959. CONTRIBUTION A L'ETUDE DES MALADIES CRYPTOGAMIQUES DES RAMEAUX ET DES JEUNES PLANTS DE PEUPLIER. [FUNGUS DISEASES OF TWIGS AND YOUNG PLANTS OF POPLAR.] [Docum.] Int. Poplar Comm., 2nd Sess. Wkg. Party on Diseases, Rome 1959 No. FAO/CIP/MAL/10, 13 pp. [F.]

Toth, I. 1958. UJABB MEGFIGYELESEK A "NYARFARAKROL." [NEW OBSERVATIONS ON POPLAR CANKER.] Erdo 7(11): 420-4. [Hu.russ.g.]
Reports 2 years' studies on the effect of plant handling, banding and individual resistance to the spread of the disease. Cutting back is useful; banding has no effect; the connection between bark necrosis and frost is quite undetermined. The resistance of 38 clones is tabulated.

Toth, J. 1957. MEGFIGYELESEIM A NYARFARAKROL. [OBSERVATIONS ON DOTHICHIZA CANKER OF POPLARS.] Erdo 6(7): 251-6. [Hu.]
From abstr. in Hung. Agric. Rev. 7(1): 11-12. 1958. [E.]

Urosevic, B. 1961. [THE CAUSE OF 'BRAUNFLECKENGRIND' OF POPLARS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(7): 605-18. 21 refs. [Cz.cz.russ.g.]
Organisms isolated from infections were: (a) Corynebacterium sp., (b) semiparasitic fungi, e.g., Dothichiza populea, Phomopsis putator, and (c) epiphytic fungi. No antagonism was found between (a) and fungi of (b) in culture. A new Corynebacterium sp., distinct from (a), was isolated from necrotic tissues of Populus × berolinensis, P. simonii and P. × robusta and this needs further study. [Cf. Oldenkamp, 1961; Meiden, 1961; and Stefanov, Zasev, and Canova, 1961; all this subject classification.]

Vanderwalle, R. 1953. NOTE SUR L'ETIOLOGIE DU CHANCRE DU PEUPLIER. [THE ETIOLOGY OF POPLAR CANKER.] Parasitica, Gembloux 9(4): 119-24. 4 refs. [F.]

Veldeman, R., and Welvaert, W. 1960. SCHORSBRAND BIJ POPULIER. [POPLAR CANKER.] Meded. LandbHogesch. Gent 25(3/4): 1107-15. [Du.du.f.e.g.]

Vlasov, A. A. 1956. RAKOVYE ZABOLEVANIJA JASENJA, DUBA, KLENA I TOPOLJA. [CANKERS OF ASH, OAK, MAPLE, AND POPLAR.] Sborn. Rabot Lesn. Hoz., VNIILM, Moskva No. 32: 243-57. [Russ.]
Types of cankers, predisposing factors, control, etc.

Waterman, A. M. [1954.] SEPTORIA CANKER OF POPLARS IN THE UNITED STATES. Circ. U. S. Dep. Agric. No. 947, 24 pp. 24 refs.

———— 1957. CANKER AND DIEBACK OF POPLARS CAUSED BY DOTHICHIZA POPULEA. For. Sci. 3(2): 175-83. 20 refs.

Wettstein, W. von, and Donaubauer, E. 1958. SURVEY OF DOTHICHIZA POPULEA. Austria. [Docum.] 14th Sess. Stand. Exec. Comm. Int. Poplar Comm., Rome 1958 No. FAO/CIP/CP/16-A, 6 pp.
Discusses distribution, symptoms, time of occurrence and location of the disease, types of poplar most susceptible, sites and water balance, prevention and control, including experiments. Spraying with Cu_2OCl_2 in May and mid-August reduced mortality of Populus robusta saplings from 13% (controls) to 1%. A Dutch preparation, Kankerdood, and Agromycin 100 are also being tested.

Zivojinovic, D. 1956. SUSENJE TOPOLA NA DELIBLATSKOJ PESCARI. [POPLAR MORTALITY ON THE DELIBLATSKA PESCARA.] Sumarstvo 9(11/12): 721-4. 5 refs. [Serb.e.f.]
Records heavy mortality in 1956 of 3- to 5-year poplar plantations as a result of attack by Dothichiza populea. The trees had suffered frost damage 3 months earlier. Damage was greatest to P. robusta, P. serotina, and P. nigra var. italica. The most resistant were P. alba, P. nigra, and P. 'Bachofeni.'

416.4/5

Lekander, B. 1963. [XYLEBORUS CRYPTOGRAPHUS (COL. IPIDAE): ITS DISTRIBUTION [IN SCANDINAVIA] AND BIOLOGY.] Ent. Tidskr., Stockh. 84(1/2): 96-109. 17 refs. [G.]

Mocanu, V. 1957. CONTRIBUTII LA STUDIUL BIOLOGIEI CIUPERCII TRAMETES GALLICA FR. F. TROGII BERK. [STUDIES OF THE BIOLOGY OF T. GALLICA F. TROGII.] An. Inst. Cerc. Silv., Bucuresti (Ser. 1) 18: 95-108. 7 refs. [Rum.russ.f.]
Detailed report on laboratory cultures and successful inoculation of healthy poplars with them. [Cf. F.A. 20, No. 2010.]

[New Zealand: Soil Conserv. Rivers Control Coun.] 1959. POPLAR INVESTIGATIONS. Extr. from Report, Soil Conservation and Rivers Control Council, Wellington 1958/1959: 26-9.

Peno, M. 1962. [THE BROWN SCAB DISEASE OF POPLARS AND WILLOWS.] Topola, Beograd 6(25/26): 19-21. [Serb.]
Discusses symptoms, susceptibility of clones, and (silvicultural) control by using plants propagated from young stock rather than from old stoolbeds, by avoidance of clones highly susceptible to fungal diseases and by early cutting of infected stands.

Raeder-Roitzsch, J. E., and Khattat, A. R. 1962. EPIDEMIC OUTBREAK OF MELANOPHILA PICTA PALL. IN IRRIGATED POPLAR PLANTATIONS IN IRAQ. [Docum.] 2nd FAO Near East Poplar Conf., Turkey 1962 No. FAO/NEPC/62/6, 13 pp. [E.e.]

Yang, Y. -C., Chou, S. -H., Li, C. -L., and others. 1957. [PRELIMINARY INVESTIGATIONS ON THE SMALL POPLAR AEGERIID (PARANTHRENE TABANIFORMIS RTT.) IN THE ENVIRONS OF THE CITY OF PEKING.] Acta Entomologica Sinica, Peking 7(1): 89-104. 8 refs [Chin.chin.russ.]

416.5

Arru, G. M. [1952.] [THE INFLUENCE OF SOIL CONDITIONS ON THE SUSCEPTIBILITY OF POPLARS TO AGRILUS VIRIDIS VAR. POPULNEA IN NORTHERN ITALY.] Proc., 5th World For. Congr., Seattle 1960, Vol. 2, Sect. 3C: 948-50. [F.e.span.]

Black, R. L. 1953. A WHITE TRUNK ROT OF POPLAR CAUSED BY "FUNGUS A." Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 9(5): 2.
About 10% of poplars in Whiteshell Forest Reserve, Man., were found to be infected with this so-far-unidentified fungus; it is generally prevalent in the Prairie Provinces and has also been found in Ontario. In cross section the incipient decay is light to rusty red with an undulating margin. In longitudinal section the advanced decay is made up of streaks of dark firm wood mixed with pockets of yellow rotten wood. The rot has a faint cheese-like odor.

Brizzi, G. 1962. [DAMAGE TO YOUNG POPLARS BY PARANTHRENE [SCIAPTERON] TABANIFORMIS.] Informatore Fitopatologico, Bologna 12(6): 81-5. [It.]
Reports extensive damage to young poplar (1-4 years) in the neighborhood of Florence, with details of the injuries caused and of the life history of the insect. Control in the nursery is easily carried out by spraying repeatedly with synthetic chlorides with or without the addition of parathion. Preliminary trials indicate that control in the field can be obtained by brushing on to the stems a mixture of paraffin and parathion and repeating at weekly intervals.

Ceianu, I. 1961. PARANTHRENE TABANIFORMIS ROTT., UN DAUNATOR AL PLOPULUI PUTIN CUNOSCUT IN R.P.R. [P. TABANIFORME, A PEST OF POPLAR LITTLE KNOWN IN RUMANIA.] Rev. Padurilor 76 (4): 242-5. 11 refs. [Rum.russ.g.f.e.]
A general account of the pest, its distribution, species attacked, and control measures, largely drawn from Russian literature.

Clausen, V. H., and Kaufert, F. H. 1952. OCCURRENCE AND PROBABLE CAUSE OF HEARTWOOD DEGRADATION IN COMMERCIAL SPECIES OF POPULUS. J. For. Prod. Res. Soc. 2(4): 62-7. 14 refs.

Cramer, H. H. 1954. UNTERSUCHUNGEN UBER DEN GROSSEN PAPPELBOCK, SAPERDA CARCHARIAS L. [INVESTIGATIONS ON S. CARCHARIAS.] Z. Angew. Ent. 35(4): 425-58. Many refs. [G.g.]

Ende, G. van den. 1951. DE KLEINE POPULICRENBOKTOR (SAPERDA POPULNEA L.) EN ZIJN BESTRIJDING. [S. POPULNEA AND ITS CONTROL.] Ned. Boschb.-Tijdschr. 23(5): 145-7. 5 refs. [Du.]
Summarizes the main points in a paper by Breny [1950, Populus sp., 453].

Georgopulos, A. 1957. BESTEHT ZWISCHEN LANGE DER FRASSGANGE, DICKE DER BEFALLENEN STELLEN UND DEM GEWICHT DER RAUPEN VON SCIAPTERON TABANIFORME EINE BEZIEHUNG? [IS THERE A CORRELATION BETWEEN THE LENGTH OF THE LARVAL GALLERIES, DIAMETER OF THE STEM PORTION ATTACKED AND THE WEIGHT OF LARVAE OF S. TABANIFORME?] Anz. Schadlingsk. 30(5): 74-6. 2 refs. [G.]
No correlation could be found between length of larval galleries, diameter of the stem portion attacked and weight of larvae nor yet between the height of the stem portion attacked and length of larval galleries.

Good, H. M. 1959. FUNGI ASSOCIATED WITH FOMES IGNIARIUS IN DECAY OF POPLAR. Abstr. in Proc. 9th Int. Bot. Congr., Montreal, Vol. 2: 136.

Guasp, J. T. 1955. LUTTE CONTRE LES PARASITES TEREBRANTS DU PEUPLIER. [CONTROL OF POPLAR BORERS.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955. No. FAO/CIP/75-K Add. 5, 3 pp. [F.]
A plantation of 60,000 poplars (3-4 cm. diam.), of which 18,000 were infested by borers, mainly Sesia apiformis and Saperda populnea (averaging two larvae/tree) was successfully treated by injecting a preparation containing 2.5% DDT plus 2.5% BHC, into the larval holes. Using a crew of three men—two to clear the holes with a piece of wire and one to inject the insecticide—the total cost per tree was 0.3 pesetas.

Kailides, D. S. 1962. [THE BIOLOGY AND CONTROL OF SCIAPTERON TABANIFORMIS IN GREECE.] [Pub.] For. Res. Inst., Minist. Agric., Athens No. 6, 15 pp. 22 refs. [Gk.e.]

Klug, W. 1954. DIE BALSAMPAPPELN ALS FANGBAUME. [BALSAM POPLARS AS TRAP TREES.] Allg. Forstztg. 65(11/12): 155-6. [G.]
The author's suggestion is based on an observation made on individual trees of Populus simonii, interspersed in stands of P. robusta and P. angulata. The former were heavily infested with Saperda carcharias and Cossus cossus, and were riddled with woodpecker holes from base to man's height, while the latter were hardly affected.

Kudler, J., and Hochmut, R. 1958. KOZLICEK OSIKOVY A MOZNOSTI BOJE PROTI NEMU. [SAPERDA POPULNEA AND ITS CONTROL.] Lesn. Prace 37(4): 174-9. [Cz.]
Describes the effects of S. populnea attack on Populus spp. in Czechoslovakia and briefly discusses various methods of chemical and biological (involving a parasite, Billaea irrorata) control.

———— Temlova, B., and Hochmut, R. 1961. ZUR FRAGE DES PAPPELSORTIMENTS UND DER INTENSITAT DES BEFALLS DURCH DEN KLEINEN ASPENBOCK SAPERDA POPULNEA L. [INTENSITY OF ATTACK BY S. POPULNEA IN RELATION TO POPLAR SPECIES AND HYBRIDS.] Commun. Inst. For. Csl. 2: 179-83. [G.]

Kurir, A. 1959. HOLZINSEKTEN-HOLZSCHUTZ. DER GROSSE PAPPELGLASFLUGLER (AEGERIA APIFORMIS) EIN PHYSIOLOGISCHER UND TECHNISCHER SCHADLING ALLER PAPPELARTEN. [SESIA APIFORMIS, A PEST OF ALL POPLARS AND POPLAR WOOD.] Allg. Holzrundschau, Wien 15(305/306). 3 pp. [G.]
Describes biology, hosts, injuries, etc., and discusses control. On park or roadside trees, the injection into flight holes of insecticides acting by inhalation is recommended.

Morani, V., and Arru, G. M. 1958. ACCUMULO DI GAS ENTRO PIOPPI IN VEGETAZIONE. [GAS ACCUMULATION IN GROWING POPLARS.] Ricerca Scientifica, Roma 28(1): 146-51. 15 refs. [It.it.f.e.g.]

Negru, S. 1951. CROITORUL RAMURILOR DE PLOP. [THE POPLAR SHOOT BORER [SAPERDA POPULNEA].] Rev. Padurilor 66(6): 7-9. [Rum.rum.russ.]
A short account of the life history, damage caused by, and control of this insect.

Pagony, H. 1955 and 1956. A NYARDUGVANOK ALGESZTESEDESE [I], II. [THE DEVELOPMENT OF FALSE HEART IN POPLAR CUTTINGS. I & II.] Erdomern. Foisk. Kozl., Sopron 1955: 111-29. 1956(1): 97-125. 19 refs. [Hu.hu.russ.g.]

———— 1956. A NYARDUGVANYOK ALGESZTESEDESE III. [THE DEVELOPMENT OF FALSE HEART IN POPLAR CUTTINGS. III] Erdomern. Foisk. Kozl., Sopron 1956(2): 103-17. 6 refs. [Hu.hu.russ.e.]

———— 1957. NYARFAALLOMANYOK EGESZSEGI ALLAPOTANAK VIZSGALATA, KULONOS TEKINTETTEL AZ ALGESZTESEDEARE. [THE HEALTH OF POPLAR STANDS IN RESPECT TO "RED HEART" INJURIES.] Erdomern. Foisk. Kozl., Sopron 1957(1): 51-63. 3 refs. [Hu. hu.russ.f.*russ.f.*]

———— 1960. EGESZSEGES ALGESZT—BETEG ALGESZT? [FALSE HEART—SOUND OR DISEASED?] Erdo 9(11): 409-13. 8 refs. [Hu.g. russ.]

Petrova, I. A. 1958. O FORMIROVANII I RAZMESCENII OCAGOV SAPERDA CARCHARIAS L. V SAVAL'SKOM LESNICESTVE. [THE FORMATION AND DISTRIBUTION OF FOCI OF INFESTATION BY S. CARCHARIAS IN SAVALSK FOREST DISTRICT.] Trudy Vsesojuznogo Instituta Zascity Rastenij, Leningrad No. 11: 74-84. 23 refs. [Russ.]

———— 1960. ROL SAPERDA CARCHARIAS L. V USYHANII TOPOLEVNIKOV SAVAL-SKOGO LESNICESTVA I PUTI ULUCSENIJA SOSTOJANIJA NASAZDENIJ. [THE ROLE OF S. CARCHARIAS IN THE DYING OF POPLAR STANDS IN THE SAVALA FOREST DISTRICT, AND WAYS OF IMPROVING STAND CONDITION.] Trudy Vsesojuznogo Instituta Zascity Rastenij, Leningrad No. 14: 31-42. 23 refs. [Russ.]

Postner, M. 1962. DER HORNISSENGLASFLUGLER, AEGERIA APIFORMIS CLERCK (AEGERIIDAE, LEPIDOPTERA) AN JUNGPAPPELN IN PFLANZGARTEN- UND BAUMSCHULEN. [ATTACK OF A. APIFORMIS ON YOUNG POPLARS IN NURSERIES.] Anz. Schadlingsk. 35(6): 81-6. 47 refs. [G.g.e.f.]

Regnier, R. 1952. IMPORTANCE DES DEGATS DE LA MINEUSE DU CAMBIUM DU PEUPLIER POUR L'INDUSTRIE DU DEROULAGE. [THE IMPORTANCE OF DAMAGE BY A CAMBIUM BORER IN POPLAR IN THE VENEER INDUSTRY.] Trans. 9th Int. Congr. Ent., Amsterdam 1951 (1): 711-4. 7 refs. [F.e.]

Schnaider, Z. 1959. Z BIOLOGII PRZEZIERNIKA OSOWCA (AEGERIA APIFORMIS CL.). [THE BIOLOGY OF A. [SESIA] APIFORMIS.] Prace Inst. Bad. Lesn. No. 190: 63-100. [Pol.russ.e.]
Gives full details of the biology and some information on the few natural enemies and silvicultural significance of S. apiformis, the larvae of which feed between the cambium and sapwood of poplars.

Srot, M. 1961. [RESULTS OF CHEMICAL CONTROL OF SAPERDA CARCHARIAS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(7): 635-52. 38 refs. [Cz.cz.russ.e.]

Templado, J. 1960. [THE BIOLOGY OF SAPERDA POPULNEA.] Boletin de la Real Sociedad Espanola de Historia Natural, Madrid 58: 135-44. 24 refs. [Span.span.e.]
Presents brief data on geographical distribution, life cycle in the Madrid area, damage caused and natural enemies.

Turcek, F. J. 1954. MECHANICKY SPOSOB ZNIZOVANIA STAVU OSIKOVNIKA DRENEHO NA TOPOLOCH. [MECHANICAL METHOD OF REDUCING POPLAR INFESTATION BY SAPERDA CARCHARIAS.] Les, Bratislava 1(11): 19-21. 3 refs. [Slovak.]

Vasic, M. 1961. SASTOJINE STARIH TOPOLA I VRBA—ZARISTA OPASNIH PARAZITA. [STANDS OF OLD POPLARS AND WILLOW—FOCI OF DANGEROUS PARASITES.] Topola, Beograd 5(24): 16-21. [Serb.f.]

Vujic, P., and Jodal, I. 1960. SUZBIJANJE MALOG TOPOLINOG STAKLOKRILCA PRIMENOM METODE UBRIZGAVANJA. [CONTROL OF SCIAPTERON TABANIFORME BY THE INJECTION METHOD.] Topola, Beograd No. 15: 21-4. [Serb.f.]
The insects, which cause serious damage to young poplars in nurseries and plantations, can be controlled by winter injection of CCl_4 or benzine into the openings of the galls formed on the stem by the larvae. Three types of syringe suitable for the purpose are illustrated.

Zivojinovic, S. 1954. MALA TOPOLINA STRIZIBUBA I TOPOLINI STAKLOKRILCI OZBILJNO UGROZAVAJU OPSTANAK KULTURA TOPOLA U VOJVODINI. [SAPERDA POPULNEA AND SESIIDAE PRESENT A SERIOUS MENACE TO THE EXISTENCE OF POPLAR STANDS IN THE VOJVODINA.] Sumarstvo 7(5): 273-7. [Serb.f.g.]
Describes the outbreaks in 1953 and 1954 of S. populnea and Sciapteron tabaniforme (and other Sesiidae) in two places in Vojvodina (500 and 150 ha., respectively).

———— 1961. [BIOLOGY AND CONTROL OF SAPERDA POPULNEA IN YUGOSLAVIA.] Z. Angew. Ent. 48(4): 410-22. 11 refs. [G.g.e.]

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

421.1

Forbes, R. S., and Davidson, A. G. 1962. EXAMINATION OF WINDTHROWN POPLAR TREES IN NEW BRUNSWICK. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 18(6): 2.
Two years after hurricane 'Donna,' most of the wind-thrown poplars (Populus tremuloides, P. grandidentata, and 'Balsam' poplar) in pulpwood stands in Charlotte County, N. B., were still alive and apparently free from borer and fungus attack and could still be salvaged.

Joachim, H.-F., and Wachter, H. 1957. UBER STURM- UND WINDSCHADEN AN PAPPELN. [GALE AND WIND DAMAGE TO POPLARS.] Forst u. Jagd 7(10): 468-70. 2 refs. [G.]
Mainly observations after severe gales in 1956 and 1957 in E. Germany. Most to suffer were trees on sites with high watertables, older or densely planted stands, and trees on the east side of roads or watercourses. Populus trichocarpa had been thrown, and P. × robusta and P. × berolinensis broken, more easily than other poplars, but differences were small.

422.1

Eichbaum, K. 1956. UBER DIE FROST-RESISTENZ UNSUER WIRTSCHAFTSPAPPELN. [FROST HARDINESS OF OUR COMMERCIAL POPLARS.] Allg. Forstzeitschr. 11(27/28): 354-5. [G.]
Discusses observations made after the hard winters of 1954-55 and 1955-56, including frost cracks, chiefly of Populus × robusta and discolorations of bark, stem, and pith, most severe on 2-year-old nursery stock. P. "deltoides missouriensis" and Italian cultivars suffered most. It was noted that plants which had been treated with B-containing fertilizer remained sound, while others from the same clones in similar sites, but untreated, were injured.

Morgeneyer, W. 1960. BEOBACHTUNGEN UBER FROSTSCHADEN UND CYTOSPORA-BEFALL IM PAPPELSORTENREGISTER IN GRAUPA NACH DER ANOMALEN WITTERUNG DER WINTER 1954/55 UND 1955/56. [FROST DAMAGE AND CYTOSPORA INFECTION IN THE POPLAR VARIETIES COLLECTION AT GRAUPA AFTER THE ABNORMAL WINTERS 1954-55 AND 1955-56.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 44 (Beitr. Pappelforsch. No. 4): 23-49. 13 refs. [G.g.russ.e.]

422.12

———— 1960. UBER SPATFROSTSCHADEN IM PAPPELSORTENREGISTER GRAUPA IM FRUHJAHR 1959. [DAMAGE BY LATE FROST IN THE SPRING OF 1959 IN THE POPLAR VARIETIES COLLECTION AT GRAUPA.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 47 (Beitr. Pappelforsch. No. 5): 43-56. 9 refs. [G.g.russ.e.]

422.15

Stawecka, W. 1961. WPLYW PRZEMARZNIECIA PEDOW TOPOLOWYCH W MATECZNIKACH ZIMA 1955/56 NA ICH PRZYDATNOSC DO PRODUKCJI SADZONEK. [EFFECT OF FREEZING OF POPLAR SHOOTS IN STOOL-BEDS IN THE 1955-56 WINTER ON THEIR SUITABILITY FOR PRODUCTION OF CUTTINGS.] Prace Inst. Bad. Lesn. No. 217: 53-69. 14 refs. [Pol.russ.g.]

422.3

Zahariev, B. J. 1947/1948. VRAHNO PREGARJANE NA ZASADENI ZA VKORENJAVANE TOPOLOVI STABLOVI REZNICI. [TOP SCORCH OF ROOTED POPLAR CUTTINGS.] Godisn. Sofijsk. Univ. (Les. Fak.) 1: 347-60. 24 refs. [Bulg.f.f.]
A study of the phenomenon, caused by too much heat in the first summer. Shading or watering reduced this form of damage considerably.

424.2

Gunzl, L. 1953. FORSTKULTURSCHADEN DURCH EIS BEI HOCHWASSER. [INJURY TO FOREST PLANTATIONS BY ICE ON FLOODWATER.]

Allg. Forstztg. 64(19/20): 252-3. [G.]
Reports on the breaking and barking of all poplar saplings in a riverain forest conversion project in the March Valley by thick ice forming on water from a 2-m. flood-rise. This happened when the floods receded rapidly, causing the ice to break up and move.

424.5

Vergnano, O. 1953. CARATTERISTICI EFFETTI DEL BORO SU PIANTE DI OLMO E PIOPPO NELLA ZONA DEI SOFFIONI BORIFERI DI TRAVALE. [TYPICAL EFFECTS OF BORON ON ELMS AND POPLARS IN THE ZONE OF THE BORON-BEARING STEAM VENTS OF TRAVALE.] Nuovo G. Bot. Ital. (n.s.) 60(1/2): 225-9. 5 refs. [It.e.]
The high B content of the soil in this area produces symptoms of injury in the leaves of poplars and elms but not of oaks. The symptoms are described and the B concentration of elms recorded —1,000 p.p.m. B_2O_3 in leaf dry matter.

424.7

Meiden, H. A. van der. 1962. KOPERGEBREK BIJ POPULIER. [COPPER DEFICIENCY IN POPLAR.] Ned. Boschb.-Tijdschr. 34(1): 29-33. 1 ref. [Du.e.e.]
Describes the symptoms (observed first on 2-year Populus × gelrica) occurring if the Cu content of the leaves drops below 4 p.p.m. dry matter (optimum 7 or over). Application of P, especially in combination with N, tends to cause Cu deficiency. This was controlled by application of 500 kg. Cu slag/ha. or, until July, by spraying with Cu preparations.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

Anonymous. 1943. RESULTADOS DE LOS ESTUDIOS DE UNA ENFERMEDAD DE LOS ABAMOS EN LA PROVINCIA DE BUENOS AIRES. [RESULTS OF STUDIES ON A DISEASE OF POPLARS IN THE PROVINCE OF BUENOS AIRES.] Maderil 16(186): 23. [Span.]

Benben, K. 1957. BADANIA NAD CHOROBAMI TOPOL W POLSCE WYWOLANYMI PRZEZ CZYNNIKI ORGANICZNE. [STUDIES ON POPLAR DISEASES CAUSED BY ORGANIC AGENTS IN POLAND.] Roczn. Nauk Lesn. No. 19: 63-122. 61 refs. [Pol.russ.e.] (Prace Inst. Bad. Lesn. No. 170.)

Citerri, R. 1944. MALATTIE DEL PIOPPE. [DISEASES OF POPLAR.] Bosco, Sept., p. 2. [It.]

Lansade, M. 1946. RECHERCHES SUR LE CHANCRE DU PEUPLIER EN FRANCE. [RESEARCH ON POPLAR CANKER IN FRANCE.] Ann. Epiph., Paris 12(1): 23-39. 28 refs. [F.]

Peace, T. R. 1939. THE RESISTANCE OF POPLARS TO CANKER AND OTHER DISEASES. NOTES ON THE SPECIES COMMONLY PLANTED IN GREAT BRITAIN. Inst. Leafl. Imp. For. Inst., Oxf. No. 1, 5 pp.

Riley, C. G. 1948. POPLAR DISEASE IN RELATION TO THINNING. For. Chron. 24(4): 321.

44/45

Bazzigher, G., Fischer, F., and Martignoni, M. E. 1957. DEGATS CAUSES AUX PEUPLIERS PAR DES INSECTES ET DES CHAMPIGNONS. [DAMAGE TO POPLARS BY INSECTS AND FUNGI.] Foret, Neuchatel 10(6): 130-40. [F.]

Dafauce, C. 1960. LAS PLAGAS DE LOS CHOPOS EN ESPANA. [PESTS AND DISEASES OF POPLAR IN SPAIN.] Bol. Serv. Plagas For., Madrid 3(5): 47-95. 24 refs. [Span.]
Brief descriptions of (1) fungus diseases, and (2) sap-sucking, defoliating, bud-mining, and stem-boring insects, with recommendations for control.

Turcek, F. J. 1956. OUTLINE OF AN ECOLOGICAL COMPLEX OF THE GENUS POPULUS WITH REGARD TO THE ZITNY ISLAND REGION. UNPUBLISHED TYPESCRIPT TRANSLATION. [1957.] 2 pp.
Transl. by F. Lachman of the summary from an article in Biologicke Prace 2(2), 1956. Emphasizes the different relationships of poplars and the organisms involved.

443 FUNGI AND BACTERIA

Anonymous. 1932. POPLAR CANKER CAUSED BY NECTRIA SPP. Mitt. Dtsch. Dendrol. Ges. 44: 447.

———— 1932. CONTROL OF POPLAR CANKER. Dtsch. Forstw. 14: 519.

———— 1944. PLANT DISEASES. NOTES CONTRIBUTED BY THE BIOLOGICAL BRANCH. Agric. Gaz. N.S.W. 55(6): 235-9. Rev. Appl. Mycol. 23: 429-30. 1944.

———— 1946. AANTASTING VAN POPULIEREN DOOR DOTHICHIZA POPULEA. [ATTACK ON POPLARS BY DOTHICHIZA POPULEA.] Ned. Boschb.-Tijdschr. 18(12): 289-90. [Du.]

Arentsen, S. 1944. HONGOS UREDINALES QUE ATACAN ANUESTROS CULTIVOS. [UREDINALES THAT ATTACK CULTIVATED PLANTS IN CHILE.] Agric. Tec., Chile 4(1): 54-6. Bblg. [Span.]

Babel. 1931. FUNGAL DISEASE ATTACKING POPLAR STEMS. Mitt. Dtsch. Dendrol. Ges. 43: 415.

Bavendamm, W. 1936. "BARK-BURN" (RINDENBRAND) OF POPLAR —A FUNGAL DISEASE. Thar. Forstl. Jb. 87(2): 177-79. [G.]

Bier, J. E. 1939. SEPTORIA CANKER OF INTRODUCED AND NATIVE HYBRID POPLARS. Canad. J. Res. 17: 195-204. Bblg.

———— 1940. STUDIES IN FOREST PATHOLOGY. III. HYPOXYLON CANKER OF POPLAR. Tech. Bull. Dep. Agric. Canad. No. 27 (Publ. 691), 40 pp. Rev. Appl. Mycol. 19: 505. 1940.

Christensen, C. M. 1940. STUDIES ON THE BIOLOGY OF VALSA SORDIDA AND CYTOSPORA CHRYSOSPERMA. Phytopathology 30(6): 459-75. Bblg.

Davis, S. H. 1942. POPLAR CANKER. A NOTE ON THE SUSCEPTIBILITY OF VARIOUS POPLAR SPECIES. Bull. Morris Arbor. 4(3): 28.

Day, W. R., and Peace, T. R. 1934. POPLAR CANKER, A PRELIMINARY NOTE. Quart. J. For. 28: 32-43.

Delacroix. 1906. CANKER IN POPLARS. Extr. from An. Inst. Nat. Agric. 2, Ser. 5, Fasc. 2, 353.

Delevoy, G., and Bourdu, M. 1935. NOTE SUR LE CHANCRE DU PEUPLIER. [NOTE ON POPLAR CANKER.] Bull. Soc. For. Belg. 42: 1-10. Bblg. [F.]

Dufrenoy, J. 1931. DISEASES OF THE POPLAR. Extr. from L'Arbre et l'Eau, 19th Congr. An. (1930), Soc. Gay-Lussac, Limoges. Pp. 113-28.

Florenzano, G. 1949. UNA SPECIE DI VALSA, NUOVA PER L'ITALIA. [A SPECIES OF VALSA, NEW IN ITALY.] Nuovo G. Bot. Ital. (n.s.) 56(4): 661-6. 5 refs. [It.]
Detailed account of appearance and life cycle of a fungus found on diseased poplars near Pisa and identified as Valsa sordida Nitschko.

Fresa, R. 1936. ARGENTINE REPUBLIC: MELAMPSORA LARICI-POPILINA IN THE DELTA OF PARANZ. Int. Bull. Plant Protect. 10(7): 145-46. Rev. Appl. Mycol. 16(1): 5. 1937.

———— 1941. ROYAS QUE ATACAN EL ALAMO HIBRIDO ITALIANO "ARNALDO MUSSOLINI" EN EL DELTA DEL PARANA (ARGENTINA). [RUSTS THAT ATTCK THE "ARNALDO MUSSOLINI" HYBRID ITALIAN POPLAR IN THE PARANA DELTA (ARGENTINE).] Rev. Argent. Agron. 8(1): 19-24. [Span.] Plant Sci. Lit. 14(22): 15.
Melampsora larici-populina and possibly M. albertensis.

Goidanich, G. 1936. ON THE CAUSES OF THE SO-CALLED "SPRING DEFOLIATION" OF THE POPLAR IN UPPER ITALY. R.C. Accad. Lincei. 24(1-2): 27-30. Rev. Appl. Mycol. 16(1): 71. 1937.

———— 1936. MORPHOLOGY, BIOLOGY AND TAXONOMY OF A FUNGUS PARASITIC ON POPLAR LEAVES (STIGMINA RADIOSA (LIB.) G. GOID.) Ann. Bot., Roma 21(2). 12 pp. Rev. Appl. Mycol. 16(6): 423. 1937.

———— 1936. PARASITIC STAINING OF TIMBER IN ITALY. III. A RED DISCOLORATION OF POPLAR WOOD CAUSED BY FUSARIUM JAVANIEUM KDS. Boll. Staz. Pat. Veg. Roma (n.s.) 16(1): 65-8. Rev. Appl. Mycol. 16(1): 5. 1937.

———— 1937. LA DELIAZIONE PRIMAVERILE DEL PIOPPO. [THE SPRING DEFOLIATION OF THE POPLAR.] Bosco 15(10). 19 pp.

———— 1937. LE STATO ATTUALE DELLE NOSTRE CONOSCENZE SULLA NATURA E SUI METODI DI LOTTA CONTRO LA DEFOGLIAZIONE PRIMAVERILE. [THE PRESENT STATE OF KNOWLEDGE ON THE NATURE OF VERNAL DEFOLIATION [OF POPLAR] AND METHODS OF CONTROL.] In Atti del Convegno di Pioppicoltura 1937: 61-79. [It.]

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Pesante, A. 1957. SECCUME DI PIOPPI IN VIVAIO. [DIE-BACK OF POPLARS IN THE NURSERY.] Notiz. Malatt. Piante (n.s.) No. 18: 65-6. [It.]
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[International: FAO/Int. Poplar Comm.] 1961. REPORT OF THE WORKING PARTY ON DISEASES, THIRD SESSION, VIENNA 1961. [Docum.] Int. Poplar Comm. 3rd Sess. Wkg. Party on Disease No. FAO/CIP/MAL/14, 22 pp. 10 refs. [E.]
Includes, as annexes: An application of the clinical approach for expressing the degree of tree vigor and vulnerability to disease (J. E. Bier) [by measuring bark turgor]; a report on a meeting on trunk scab disease at Stuttgart-Weilendorf, Aug. 6, 1961; and a virus disease of poplars (T. M. Berg) [in the Netherlands].

45 DAMAGE BY ANIMALS

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453 INSECTS

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M. decastigma attacks 3- to 25-year poplar, and G. dealbana mainly young poplar plants. Observations are presented on the damage they inflict and on their life-history, and brief recommendations are made for their control.

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An annotated list of pests, with fuller notes on S. tabinforme and M. decastigma and their control.

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Gives interim results of observations on Agrilus and Buprestis, covering damage, and counter-measures.

———— 1962. [PLANNING PROTECTION AGAINST INSECT PESTS ON POPLARS.] Topola, Beograd 6(29/30): 36-9. [Serb.f.]
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MacDougall. 1912. WILLOW AND POPLAR LEAF BEETLES. Extr. J. Bd. Agric., Oct., pp. 555-60.

Maheux, G. 1940. LE LIPARIS DU SAULE (STILPNOTIA SALICIS L.) DANS QUEBEC. [THE WILLOW LIPARID MOTH (STILPNOTIA SALICIS L.) IN QUEBEC.] Nat. Canad. 67(2/3): 73-8. Bblg. [F.] Rev. Appl. Ent. A29: 626.

Miklos, I. 1960. PRILOG POZNAVANJU STETNIH INSEKATA NA TOPOLAMA U N.R. HRVATSKOJ. [INSECT PESTS OF POPLAR IN CROATIA.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 2: 55-67. 19 refs. [Serb.g.]
Lists some 69 insects found on poplar in studies in 1956-57. Besides known pests, a number of insects rarely found on poplar were noted, including Ceresa bubalus, Mamestra persicariae, and Cimbex femorata.

Morris, R. C. 1960. CONTROL OF COTTONWOOD INSECTS WITH A SYSTEMIC INSECTICIDE. J. For. 58(9): 718.

[Netherlands: Itbon] 1962. POPULIERENINSEKTEN. [POPLAR INSECTS.] Meded. Inst. Toegep. Biol. Onderz. Nat. No. 57: 42-4, 49. [Du.e.]
Discusses damage by Cryptorrhynchus lapathi, Stilpnotia salicis, and Phloeomyzus redelei.

Nishiguchi, C. 1963. [PESTS OF POPLAR IN JAPAN.] Anz. Schadlingsk. 36(6): 85-8. [G.]

Nogueira, C. D. S. 1957. ALGUNS INSECTOS DA BIOCENOSE DOS CHOPOS EM PORTUGAL. [SOME INSECTS OF THE POPLAR BIOCOENOSIS IN PORTUGAL.] Publ. Serv. Flor. Aquic. Portugal 24(1): 41-177. 99 refs. [Port.port.e.]

Patocka, J. 1955. POZNAMKY O SKODCOCH NA TOPOL'OCH R. 1953. [NOTES ON POPLAR PESTS, 1953.] Lesn. Sborn. Slov. Akad. Vied No. 1: 45-69. 13 refs. [Slovak.slovak.russ.g.]
Discusses larvae of several species of insect found damaging leaves, and gives a morphological key to the adult larvae of the genus Pygaera.

Rafes, P. M. 1960. NASEKOMYE-VREDITELI TOPOLEJ, OSIN I IV, PROIZRASTAJUSCIH NA NARYNSKIH PESKAH POLUPUSTYNNOGO ZAVOLZ JA. [INSECT PESTS OF POPLARS, ASPENS AND WILLOWS GROWING ON THE NARYN SANDS IN THE TRANS-VOLGA SEMI-DESERT.] Trud. Inst. Les. No. 48: 102-28. 51 refs. [Russ.]

Regnier, R. 1960. POPLAR INSECT PESTS. SURVEY NO. 4, CRYPTORRHYNCHUS LAPATHI. SURVEY NO. 5, SCIAPTERON TABANIFORME SURVEY NO. 6, CAPNODIS. [Docum.] Int. Poplar Comm. Wkg. Party on Insects Nos. J 6838; J 6838a; J 6838b. 2 pp. each. [E.]
Three questionnaires, each preceded by brief notes.

Rohrig, E. 1955. UBERSICHT UBER DIE BISHER BEOBACHTETEN INSEKTEN AN DER PAPPEL. [REVIEW OF INSECTS FOUND ON POPLAR.] Anz. Schadlingsk. 28(3): 33-40. [G.]
The review is based on literature and is presented in the form of a table showing species, date, and locality of discovery, and by whom discovered.

Romanyk, N. 1958. LA SITUACION DE PLAGAS DE INSECTOS FORESTALES EN ESPANA EN 1958. [THE SITUATION WITH REGARD TO FOREST INSECT PESTS IN SPAIN, 1958.] Bol. Serv. Plagas For., Madrid 1(2): 89-93. [Span.]
A short review of the situation including lists of species attacking poplar and pine.

Silver, W. H. 1942. THE FUNGUS FLORA OF AN INSECT GALL. Abstr. in Proc. Ind. Acad. Sci. 1941(51): 75.

Soules, B. 1961. KATAPOLEMESIS ASTHENEION LEUKES. [CONTROL OF POPLAR PESTS.] Das. Chron. 3(2): 104-7. [Gk.]
The author presents a table to assist poplar cultivators in Greece, and particularly Macedonia, to identify the various insect pests (26 are listed) and control their attacks.

Stefanov, D., and Daskalova, I. 1962. [SOME UNSTUDIED AND NEW INSECT PESTS OF POPLARS IN BULGARIA.] Nauc. Trud. Lesoteh. Inst., Sofija 10: 73-7. 8 refs. [Bulg.g.]
Discusses 8 species of Lepidoptera, 8 Coleoptera, and 2 Coccidae.

[Switzerland: Schweiz. Anst. Forstl. Versuchsw.] 1955. INSEKTEN UND PILZKRANKHEITEN DER PAPPELN. [INSECTS AND FUNGUS DISEASES OF POPLARS.] Kurzmitt. Schweiz. Anst. Forstl. Versuchsw. No. 4, 11 pp. [G.]
Contains a classified list of 259 insect species occurring on poplars. Of the 26 species known to be injurious, the eight most serious pests are discussed, with notes on control. Forty-two pathogens, mostly fungi, are also discussed with reference to the diseases caused and (where possible) suggested control measures and the susceptibility of various poplar varieties.

Vivani, W. 1955. OCCORRE PROTEGGERE FIN DALL'INIZIO I NUOVI PIOPPETI VENETI DAGLI INSETTI XILOFAGI. [THE PROTECTION OF YOUNG VENETIAN POPLAR PLANTATIONS FROM WOOD-EATING INSECTS.] Cellulosa e Carta 6(7): 7-10. [It.]
Summarizes current methods of controlling Cossus cossus, Saperda spp., and Cryptorrhynchus lapathi on young poplars.

Wettstein, O. 1959. ZUR BIOLOGIE VON PAPPELSCHADLINGEN IN WINDSCHUTZSTREIFEN. [THE BIOLOGY OF POPLAR PESTS IN SHELTERBELTS.] Cbl. Ges. Forstw. 76(2): 84-106. 9 refs. [G.]

Zarco, E., and Ceballos, G. 1956. INSECTOS PERJUDICIALES AL CHOPO EN ESPANA. [INSECTS DAMAGING POPLAR IN SPAIN.] Servicio de Plagas Forestales, Direccion General de Montes, Caza y Pesca Fluvial, Ministerio de Agricultura, Madrid. 125 pp. [Span.]
Illustrated descriptions with notes on the life history of a large number of Coleoptera and Lepidoptera and also a few Hemiptera and Diptera.

Zivojinovic, S. 1957. NAJZNACAJNIJI STETNI INSEKTI MEKIH LISCARA U TOKU 1956 GODINE. [THE MOST IMPORTANT INSECT PESTS OF POPLAR AND WILLOW IN 1956.] Topola, Beograd 1(2): 81-92. 4 refs. [Serb.serb.f.]
Lists 14 species of insect pests occurring in dense populations in Serbia in 1956 and causing damage to poplar and willow plantations. Species belong mainly to the Coleoptera and Lepidoptera, with one species each from the Homoptera, Hymenoptera and Acari. Some notes are given on the extent of the damage, and the biology of the insects.

———— and Tomic, D. 1956. STETNI INSEKTI MEKIH LISCARA. (PRVI PRILOG.) [INSECT PESTS OF WILLOWS AND POPLARS. (FIRST CONTRIBUTION.)] Suppl. to Zast Bilja No. 34, 22 pp. 24 refs. [Serb.serb.e.]
Lists 69 species of various orders found in 1953-55 along the rivers Danube and Tisa, with notes on type and extent of damage by the more important of them.

459 OTHER ANIMALS

Jodal, I. 1962. [SOME EXPERIMENTS IN THE CONTROL OF TETRANYCHIDS ON POPLARS.] Topola, Beograd 6(28): 88-90. 4 refs. [Serb.f.]
Mass outbreaks of a so-far unidentified tetranychid mite have occurred during recent years in poplar nurseries in Vojvodina. They have been successfully controlled by spraying with 0.15% diazinon.

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Moriondo, F. 1955. ALTERAZIONI SU PIANTE DI PIOPPO IN SEGUITO A CRISI DI ATTECCHIMENTO. [A DIE-BACK OF POPLARS FOLLOWING TRANSPLANTATION SHOCK.] Ann. Accad. Ital. Sci. For. 4: 345-86. 22 refs. [It.f.]
A detailed study, illustrated by 30 photomicrographs, of a disorder occurring in hybrid poplars transplanted when 4 m. high. In the following spring they developed stem cankers caused by a fungus of the Sphaeropsidales, and in the following autumn extensive top-dying above hypertrophy of the bark in the neighborhood of epicormic shoots. This disorder is ascribed to inadequate root development due to transplantation shock. Anatomical changes in the affected parts are described in detail.

5 FOREST MENSURATION

52 MEASUREMENTS OF THE STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS, AND TIMBER

52/56

[Germany: Dtsch. Akad. LandwWiss.] 1960. FRAGEN DER ERTRAGSKUNDE UND DER HOLZMESSKUNDE BEI DER ARBEIT MIT FORSTLICHEN VERSUCHSFLACHEN. [YIELD AND MENSURATION STUDIES BASED ON FOREST SAMPLE PLOTS.] Tagungsbericht, Dtsch. Akad. LandwWiss., Berlin No. 26, 175 pp. 15 refs. [G.g.russ.e.]

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

[Germany: Forst- u. Holzw.] 1962. SONDERHEFT PAPPEL. [SPECIAL NUMBER: POPLARS.] Forst- u. Holzw. 17(12): 225-44. 28 refs. [G.]

524.12

Bryndum, H. 1957. FORMTAL FOR POPPEL. [FORM FACTORS FOR POPLAR.] Dansk Skovforen. Tidsskr. 42(3): 193-6. [Dan.] (Kort Meddelelse fra Statens Forstlige Forsogsvaesen No. 25.)
Form factors for total volume and for merchantable volume for different diameters and heights are shown in graphs. Because of the smallness and heterogeneous nature of the material (6 species and hybrids were included) the results can only be indicative.

524.3

Sopp, L. 1957. HAZAI NYARASAINK FATOMEG- ES TORZALAK-VIZSGALATANAK EREDMENYEI. [RESULTS OF INVESTIGATIONS ON THE VOLUME AND STEM FORM OF HUNGARIAN POPLAR STANDS.] Erdo 6(11): 429-38. [Hu.]
From abstr. in Hung. Agric. Rev. 7(2): 9. 1958. [E.]

524.315

Kubita, S., and Roupec, J. 1956. ZJIST'OVANI HMOTY TOPOLU NA STOJATE. [ASSESSMENT OF THE VOLUME OF STANDING POPLAR TREES.] Lesn. Prace 35(1): 21-7. [Cz.]

Sopp, L. 1957. A HAZAI NYARAK FATOMEGE. [VOLUME TABLES FOR POPLARS IN HUNGARY.] Erdesz. Kutatas., Budapest 1957(3/4): 15-72. 13 refs. [Hu.russ.g.e.]
Volumes tables were constructed for (a) Populus canescens and P. alba, and (b) P. nigra, based on 2,683 trees of (a) and 835 of (b).

54 ASSESSMENT OF SITE QUALITY

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Keresztesi, B. 1960. NEHANY ADAT NYARASAINKROL. [SOME DATA ON OUR POPLAR STANDS.] Erdo 9(5): 171-4. [Hu.russ.g.]
The county working-plan statistics and Magyar's poplar yield table (compiled for local conditions), show that ¼, >½, and almost ¼ of Hungary's indigenous poplar stands are respectively good, moderate, and poor. Of the exotic species the proportions are >½, almost 1/6 and 1/3. The good-quality stands of both categories are on the flood-plains, the moderate quality of indigenous poplars in the sand regions between Danube and Tisza, while poor qualities are generally in the hills and mountains.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Anonymous. 1918. GROWTH OF POPLARS. Quart. J. For. 12: 132.

Ahmad, G. 1962. POPLARS IN WEST PAKISTAN. Pakistan J. For. 12(1): 80-3.
Gives some growth data for native and introduced poplars, including the indigenous Populus ciliata, P. alba, P. nigra, and P. euphratica, and the introduced P. × euramericana 'eugenii', 'canadense', 'I-214', 'I-154', and P. wiszlenii.

Bergogne, L., and Parde, J. 1963. [THE PRODUCTIVITY OF THE POPLAR PLANTATIONS OF THE GARONNE VALLEY.] Rev. For. Franc. 14(4): 261-79. [F.]
Gives data in increment and yield for a number of varieties and clones, and soil analyses for some sample plots.

Korsun, F. 1954. TAXATEUR SUR LA CULTURE DES PEUPLIERS. [A MENSURATION OFFICER ON POPLAR-GROWING.] FAO typescript translation, [n.d.] 5 pp. [F.]
Transl. from Les, Bratislava 1954(12): 12-5. Presents a table of stocking showing number and volume of trees removed in thinning, reserve volume at 30 years, total production and m.a.i. over 30 years, based on 258 sample plots from different parts and representing the main poplar species grown in Czechoslovakia, and five site classes.

Piccarolo, G. 1950. QUALCHE DATO SULLA PRODUZIONE LEGNOSA CORMOMETRICA DI FUSTAIE COETANEE DI PIOPPI, CRESCIUTE NEI TERRENI GOLENALI DEL CASALESE (PROV. DI ALLESSANDRIA). [SOME MENSURATIONAL DATA ON THE GROWTH AND YIELD OF EVEN-AGED STANDS OF POPLAR IN THE FLOODLANDS OF CASALE (ALEXANDRIA PROVINCE).] Monti e Boschi No. 6: 266-8. [It.]

Pratt, E. R. 1918. THE INITIAL GROWTH OF VARIOUS POPLARS. Quart. J. For. 12: 132-5.

Schletter, A. 1954. BETRACHTUNGEN ZUR WECKSCHEN METHODE DER WACHSTUMSDIAGNOSE. [WECK'S METHOD OF GROWTH ANALYSIS.] Arch. Forstw. 3(3/4): 193-205. 8 refs. [G.]

Susmel, L. 1953. CAPACITA PRODUTTIVA DELLE SPECIE LEGNOSE. [THE PRODUCTIVE CAPACITY OF WOODY SPECIES.] Monti e Boschi 4(2): 51-8. 14 refs. [It.f.e.]
Compares the yield of three typical, pure, even-aged stands of spruce, poplar, and eucalypt (E. rostrata) having respective rotations of 150, 15, and 12 years. M.a.i. in volume is in the ratio 1:2.9:3.6, but increment in drywood weight is in the ratio 1:2.8:5.

Trifunovic, D., and Popovic, C. 1960. PROIZVODNA SPOSOBNOST SASTOJINA NAJRASIRENIJIH VRSTA TOPOLA U AP VOJVODINI. [THE PRODUCTIVE CAPACITY OF STANDS OF THE MOST WIDELY USED POPLAR SPECIES IN VOJVODINA.] Sumarstvo 13(7/8): 359-73. 19 refs. [Serb.f.f.]
Presents data on c.a.i./ha. for Populus robusta, P. serotina, P. nigra, and P. alba plantations calculated from 320 sample stems cut on 22 plots in the Danube, Sava, and Tisa River areas. Regression equations derived from these data are given for height, b.a., and volume increment. An equation is also given for bark thickness.

561.21

Herbignat, A. 1952. ACROISSEMENTS ANNUELS MOYENS DE QUELQUES TYPES DO PEUPLIER EN BELGIQUE. [MEAN ANNUAL [GIRTH] INCREMENT OF SOME POPLARS IN BELGIUM.] Bull. Soc. For. Belg. 59(7): 335-7. [F.]
Gives preliminary data for several clones of Populus serotina, P. deltoides f. virginiana, P. robusta, P. regenerata, and P. marilandica.

Nitu, G. 1962. [DIAMETER INCREMENT OF POPLAR STANDS DURING THE GROWING SEASON.] Rev. Padurilor 77(11): 658-61. 4 refs. [Rum.]

Poskin, A. 1955. ACCROISSEMENTS ANNUELS EN CIRCONFERENCE DE PEUPLIERS DE CULTURE EN BELGIQUE. [ANNUAL GIRTH INCREMENT OF POPLARS GROWN IN BELGIUM.] Spec. Pap. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 93-6. [F.]
Tabulates girth increment data for 15 years, for Populus virginiana, P. robusta, P. regenerata, P. serotina, and P. marilandica. [Cf. Herbignat, above.]

562.2

Darbellay. 1914. ON THE VOLUME YIELD OF THE ITALIAN POPLAR. J. For. Suisse 65: 114-9.

566 YIELD TABLES AND THEIR CONSTRUCTION

Christie, J. M. 1959. PRELIMINARY YIELD TABLE FOR POPLAR. For. Rec. For. Comm., Lond. No. 40, 14 pp. 2 refs.

Dawany. 1867. NOTES ON THE YIELD OF POPLAR. Monatschr. F. & J. 9: 197-8.

Hoffmann, A. 1937. THE YIELD OF POPLAR IN NORTHERN ITALY. L'Alpe 24(7): 261-67.

Schmitz-Lenders, B. 1948. PAPPEL- ERTRAGS- UND MASSEN-TAFELN. [YIELD AND VOLUME TABLES FOR POPLAR.] Verlag von M. & H. Schaper, Hannover. 29 pp. [G.]

6 FOREST MANAGEMENT

De Lotbiniere, H. G. J. 1948. POPLAR FOR QUICK RETURNS. Quart. J. For. 42(1): 27-31.
Discusses possibilities of commercial growing of poplar in Britain.

[Italy: Ente Naz. Cellulosa] 1954. ATTI DEL CONGRESSO NAZIONALE DEL PIOPPO (ROVIGO 15 NOVEMBRE 1953). [PROCEEDINGS OF THE [ITALIAN] NATIONAL POPLAR CONFERENCE (ROVIGO 15 NOV. 1953).] Pubbl. Ente Naz. Cellulosa Carta, Roma 1954. 257 pp. [It.]
The papers and discussions deal mainly with the economic aspects of poplar growing in Italy. An exception is a paper by D. Rui, G. Giraldi, and F. Bellavito on poplar pests in Veneto, dealing with outbreaks of (1) Phloeomyzus passerinii, and (2) Dothichiza populea.

Koltay, G. 1949. A NYARFA ERDOGAZDASAGI JELENTOSEGE. [THE SIGNIFICANCE OF POPLARS IN FORESTRY.] Erdesz. Lap. 85(8): 172-7. [Hu.russ.f.e.g.]

Razzetti. 1929. POPLAR PRODUCTION IN THE VALLEY OF THE PO. L'Alpe 16: 249-54.

———— 1929. POPLAR PRODUCTION IN THE VALLEY OF THE PO. L'Alpe 16: 393-9.

613 EXPLOITABILITY AND ROTATION

Allegri, E. 1955. DETERMINATION DE L'EPOQUE D'ABATTAGE DES PEUPLIERS EN FONCTION DE LA FORME DU FUT. [DETERMINATION OF EXPLOITABLE AGE OF POPLARS AS A FUNCTION OF STEM FORM.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-F, 3 pp. [F.]
Discusses the factors involved, in general terms.

Giordano, G. 1959. DE LA DETERMINATION EXACTE DE LA ROTATION DE PRODUCTION MAXIMUM DES PLANTATIONS DE PEUPLIER. [THE EXACT DETERMINATION OF THE ROTATION OF MAXIMUM VOLUME PRODUCTION IN POPLAR PLANTATIONS.] [Docum.] 10th Sess. Int. Poplar Comm., Italy 1959 No. FAO/CIP/95-F Add. 1, 5 pp. [F.]

————1959(1960). STUDIO ANALITICO DEL TURNO DI MASSIMA PRODUZIONE LEGNOSA APPLICATO AI PIOPPETI DI IMPIANTO ARTIFICIALE. [ANALYTICAL STUDY OF THE ROTATION OF MAXIMUM VOLUME PRODUCTION IN POPLAR PLANTATIONS.] Pubbl. Cent. Sper. Agric. For., Roma No. 3: 181-91. [It.it.e.e.]

Gonet, B. 1952. ZAGADNIENIE WIEKU REBNOSCI W UPRAWACH TOPOLOWYCH DLA PRODUKCJI DREWNA CELULOZOWEGO. [THE PROBLEM OF FELLING AGE IN POPLAR PULPWOOD PLANTATIONS.] Sylwan 96(4): 387-433. 29 refs. [Pol.pol.russ.e.]

651 CALCULATION OF COSTS AND PROFITABILITY

Bornand, G. -H. 1956. LA RENTABILITE DU PEUPLIER. [THE FINANCIAL YIELD OF POPLARS.] Schweiz. Z. Forstw. 107(8/9): 458-66. [F.g.]
An analysis of quantities cut, assortments obtained and prices realized from poplars grown in a mixed bottom-land forest bordering Lake Murten (Neuchatel), over a number of years, and recommendations for making poplar-growing more profitable.

651.6

[Netherlands: Landbouw-Economisch Instituut] 1951. KOSTPRIJSBEREKENING VOOR HOUT VAN GROVEDEN, DOUGLAS, POPULIER, EN INLANDSE EIK. [CALCULATING THE COST PRICE OF TIMBER OF SCOTS PINE, DOUGLAS FIR, POPLAR, AND NATIVE OAK.] Rapport, Landbouw-Economisch Instituut, Den Haag No. 144, 47 pp. [Du.]

———— 1952. HERBEREKENINGEN VAN DE KOSTPRIJZEN VOOR HOUT VAN GROVEDEN, DOUGLAS POPULIER ON INLANDSE EIK (RAPPORT NR. 144) IN VERBAND MED DE GEWIJZIGDE LOONKOSTEN. [A FRESH CALCULATION OF COST PRICE OF TIMBER OF SCOTS PINE, DOUGLAS FIR, POPLAR, AND NATIVE OAK (REPORT NO. 144) IN CONNECTION WITH THE REVISED WAGE SCALES.] Nota, Landbouw-Economisch Instituut, Den Haag No. 98, 21 pp. [Du.]

651.71

Madas, A. 1961. A NYARFATERMESZTES GAZDASAGOSSAGA. [THE PROFITABILITY OF POPLAR CULTURE.] Erdo 10(5): 174-80. [Hu.g. russ.]
A thorough logging study with calculations based on yield tables shows that poplar raising on the best sites is, even by industrial standards, a very profitable investment. Its importance in soil utilization is also illustrated. Dollar and forint data are tabulated.

Schutze, G. [1959?] ZIELE UND GRENZEN DES PAPPELANBAUES IN WESTDEUTSCHLAND. [TARGETS AND LIMITS OF POPLAR GROWING IN WEST GERMANY.] Deutscher Pappelverein und Lignikultur, Bonn. 52 pp. 42 refs. [G.g.]
Examines supply of and demand for wood in W. Germany and Europe, and for poplar wood in W. Germany. Concludes that within this century demand is likely to exceed supply, and that the only limitation to poplar growing is the availability of suitable sites. [Cf. Volkmann, 1958, P. robusta to P. sukashewi, 566, and Stegmann, 1959, Populus sp., 2.]

653 VALUE INCREMENT OF THE STEM; DEVELOPMENT AND STRUCTURE OF THE STAND AS REGARDS VALUE

Darbellay. 1914. FINANCIAL YIELD OF ITALIAN POPLAR. J. For. Suisse 20: 50-4.

7 MARKETING OF FOREST PRODUCTS. ECONOMICS OF FOREST TRANSPORT AND THE WOOD INDUSTRIES

73 PRICES

Anonymous. 1931. NEED FOR MORE POPLAR TIMBER. Dtsch. Forstw. 13: 771.

8 FOREST PRODUCTS AND THEIR UTILIZATION

[International: FAO Near East Poplar Conf.] 1954. LOGGING AND UTILIZATION OF POPLAR WOOD. NOTE OF THE SECRETARIAT. [Paper] Near East Poplar Conf. 1954, FAO, Rome. No. FAO/NEPC/7, 14 pp. [E.]
Suggests possible uses and recommends desirable lines of research. Forms for recording measurements of sample trees and tests on wood samples are annexed.

Kanzler. 1953. VERWERTUNGSMOGLIOHKEITEN VON PAPPELHOLZ. [POSSIBILITIES OF USE OF POPLAR WOOD.] Holz-Zbl. 79(57): 641-2. [G.g.]

Najera y Angulo, F. 1960. APLICACIONES INDUSTRIALES DE LA MADERA DE CHOPO: ESTUDIO TECNICO Y ECONOMICO. [INDUSTRIAL USES OF POPLAR WOOD: TECHNICAL AND ECONOMIC STUDY.] In Conferencias sobre el chopo y sus applicaciones, Seccion de Publicaciones de la Escuela Tecnica Superior de Ingenieros de Montes, Madrid. Pp. 67-97. [Span.]
Reviews (1) the properties and characteristics of poplar wood, (2) its industrial uses, and (3) its management in various parts of the world.

———— 1962. LAS MADERAS DE CRECIMIENTO RAPIDO Y LA EXPANSION INDUSTRIAL DE ESPANA. [FAST-GROWING TIMBERS AND INDUSTRIAL EXPANSION IN SPAIN.] Inst. For. Invest. Exp. Madrid. 72 pp. 4 pp. of refs. [Span.]
Reviews briefly the Spanish situation with reference to the production and consumption of wood, states the need for establishing quick-growing species, and summarizes information on the properties and uses of poplar, and on its management.

Van Tilt. 1929. NOTE ON COMMERCIAL USES OF POPLAR IN BELGIUM. Bull. Soc. For. Belg. 32: 410.

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

[International: FAO Conf. Mech. Wood Technol.] [1952.] REPORT OF SECOND CONFERENCE ON MECHANICAL WOOD TECHNOLOGY, 6-18 AUGUST 1951. Igls, Austria. FAO, Rome No. FAO/52/5/2789, 71 pp.
Reports include: (1) recommended methods of test for evaluating the properties of fibre building boards; (2) proposed standard procedure for the mechanical testing of veneer, plywood, and allied materials; (3) progress reports on timber tests; (4) stress-grading of structural timber; and (5) nomenclature of commercial timbers; with an appendix: Mechanical and industrial testing of poplar wood, by G. Giordano.

Kubinsky, E. 1955. PRIEMYSELNA SPRACOVATEL'NOST' TOPOL'OV A Z TOHO VYPLYVAJUCE POZNATKY PRE ICH PESTOVANIE. [INDUSTRIAL UTILIZATION OF POPLARS AND ITS EFFECT ON SILVICULTURAL PRACTICE.] Les, Bratislava 2(1/2;3): 24-8; 86-93. [Slovak.]

Launprecht. 1870. BRANCH WOOD OF POPLAR AND BIRCH. Allg. Forst- u. Jagdztg. 46: 449-51.

810 GENERAL INFORMATION ON WOOD

Anonymous. 1941. PAPPEL. [POPLAR] Holz 4: 231. 9 refs. [G.]

———— 1941. SPECIMEN WOODS NO. 65: POPLAR (POPULUS SPP.). Wood 6(4): 95-96.

Betts, H. S. 1945. AMERICAN WOODS: COTTONWOOD. U. S. For. Serv. 8 pp.

Clonaru, A., Ocskay-Clonaru, S., and Bindiu, C. 1961. INSUSIRI TEHNOLOGICE ALE LEMNULUI SI CELULOZEI PLOPILOR DIN R.P.R. [TECHNICAL PROPERTIES OF WOOD AND PULP FROM POPLARS GROWN IN RUMANI.] Rev. Padurilor 76(8): 490-6. 7 refs. [Rum.russ. g.f.e.]

Cox, H. A. 1942. HOME-GROWN POPLAR. Wood 6(7): 117.

Gonet. 1927. QUALITIES AND USES OF POPLAR. J. For. Suisse 78: 217.

Henderson, F. Y. 1950. HOME-GROWN POPLAR. J. Land Agents' Soc. 49(2): 47-8.

Irwin, J. D., and Doyle, J. A. 1961. PROPERTIES AND UTILIZATION OF CANADIAN POPLARS. Tech. Note For. Prod. Res. Br. Can. No. 24, 28 pp. 14 refs.
Deals with Populus tremuloides, P. grandidentata, P. balsamifera, P. deltoides, P. trichocarpa, P. acuminata, P. angustifolia, and P. sargentii.

Mayer-Wegelin, H. 1951. POPLAR WOODS PROPERTIES AND USES. Transl. For. Prod. Lab., Can. No. 63. 1953. 11 pp.
Transl. by O. Feihl from Das Pappelbuch (editor H. Hesmer). [See Hesmer, 1951, Populus sp., 0.]

Stojanov, V., and Encev, E. 1950. PRINOS KAM IZUCAVANE TEHNOLOGICESKITE KACESTVA NA TOPOLOVATA DARVESINA OT CUZDOZEMNITE VIDOVE TOPOLI, KULTIVIRANI U NAS. [THE TECHNOLOGICAL PROPERTIES OF THE WOOD OF EXOTIC POPLAR SPECIES CULTIVATED IN BULGARIA.] Izvestija na Biologiceskija Institut, Otdelenie za Biologiceski i Medicinski Nauki, Balgarska Akademija na Naukite, Sofia No. 1: 157-202. [Bulg.bulg.f.]
Species tested are P. prjewalski, P. canadensis, and P. pyramidalis.

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811.158

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812 PHYSICAL AND MECHANICAL PROPERTIES

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A preliminary report on studies made by the Centre Technique du Bois at the suggestion of the International Poplar Commission, in order to determine standard methods of testing poplar wood. The study was made on 14 logs of the hybrid P. robusta from seven trees of different provenances and included sawing, seasoning, and veneer peeling as well as mechanical strength tests.

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Contains data on green weight/c.c. of wood of individual annual rings of P. regenerata grandis, their lignin and cellulose content in connection with the amount of tension wood they contain. Within each annual ring green weights are fairly stable, and each piece of timber is fairly homogeneous as regards strength properties, but there are great differences between various hybrids. Chipboards from poplar wood are stronger per unit weight than, e.g., spruce chipboard, but the low weight means lower output per cu.m. of wood.

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Pallay, N. 1957. AMAGYARORSZAGI TERMUHELYEKEN NOTT NYARFAJOK MUSZAKI TULAJDONSAGAI. [THE [WOOD] PROPERTIES OF SOME POPULUS SPP. GROWN IN HUNGARY.] Erdomern. Foisk. Kozl. No. 2: 33-78. [Hu.]
Tabulates and graphs physical and mechanical properties of samples of P. alba, P. nigra, P. tremula, P. × marilandica, P. × serotina, and P. × robusta grown in Hungary.

812.152

Stofko, J., and Adamca, M. 1956. PRISPEVOK K POZNANIU DIELEKTRICKYCH VLASTNOSTI NASICH DREVIN A GLEJOV. [DIELECTRIC PROPERTIES OF CZECHOSLOVAK TIMBERS AND GLUES.] Drev. Vyskum 1(1/2): 69-82. 7 refs. [Slovak.slovak.russ.g.]

812.31

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812.72

Giordano, G., and Curro, P. 1956. COMPRESSION STRENGTH IN THE WOOD OF THREE POPLAR STEMS WITH RESPECT TO THEIR SPECIFIC GRAVITY. [Docum.] 12th Congr. Int. Union For. Res. Organ., Oxford 1956 No. IUFRO/56/41/6 Rev. 10 pp. 2 refs. [E.]
For all three poplars (two trees of P. × eurameriana "I 214", one each from Alessandria and Pisa, and one tree of P. tremula from Cosenza), compression strength increased with specific gravity. Graphs show experimental and calculated results.

Walkenhorst, R. 1956. UNTERSUCHUNGEN AN PAPPELHOLZ. [INVESTIGATIONS INTO [STRENGTH PROPERTIES OF] POPLAR WOODS.] Holz-Zbl. 82(124): 1507-9. 16 refs. [G.g.]
Analysis of more than 2,000 samples taken from 12 stems (in all) of Populus robusta, P. regenerata, P. serotina, P. trichocarpa, and P. berolinensis from four German sites indicated that mean compressive strength was greatest in P. robusta and lowest in P. trichocarpa, tended to be higher on the better sites and to increase up the stem. The amount of tension wood present (greatest in P. robusta) and its distribution showed no connection with site or wind direction. Mean strength of samples containing tension wood was 2.3% less than that of samples without, but for samples from identical growth layers the difference was 18% ovendry, and 45.2% green.

813 WOOD CHEMISTRY

[France] 1951. ETUDES CHIMIQUES DE DIVERSES ESPECES DE PEUPLIERS. [CHEMICAL STUDIES OF DIFFERENT SPECIES OF POPLAR.] Rapp. Fonds For. Nat. Jan.-Juin 1951: 52. [F.]

Guillemain-Gouvernel, J. 1952 and 1954. ETUDE CHIMIQUE DE DIFFERENTS TYPES DE PEUPLIERS. [CHEMICAL ANALYSIS OF DIFFERENT TYPES OF POPLARS.] Memorial des Services Chimiques de l'Etat, Paris 37(4): 293-6; 39(4): 231-3. [F.]
Presents the chemical analysis of the wood of several poplars of the sections Aigeiros and Tacamahaca or hybrids, giving cellulose and lignin content, extractives, furfural index and ash content in relation to dry weight, with data on site, age of tree, and

position of sample in tree. Research into effects of variety, site factors, age, etc., continues.

Jayme, G. 1949. CHEMISCHE UNTERSUCHUNGEN AN PAPPELHOLZERN. [CHEMICAL RESEARCH ON POPLAR WOODS.] Papier, Darmstadt 3(17/18): 339-42. 10 refs. [G.]

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Extractives of a liquor from the pulping of peeled mixed aspen (Populus tremuloides, P. grandidentata, and P. tacamahaca were investigated). [Cf. Pearl and Beyer, 1960, P. tremuloides, 813.]

———— and Justman, O. 1961. STUDIES ON THE CHEMISTRY OF ASPENWOOD. XIII. FURTHER STUDIES OF THE NEUTRAL EXTRACTIVES OF COMMERCIAL ASPEN SPENT SULFITE LIQUOR. J. Organ. Chem. 26(9): 3563-4. 10 refs.

———— and McCoy, P. F. 1961. STUDIES ON THE CHEMISTRY OF ASPENWOOD. VIII. AN INVESTIGATION OF THE NEUTRAL EXTRACTIVES OF COMMERCIAL SPENT ASPEN LIQUOR. [FROM POPULUS TREMULOIDES, P. GRANDIDENTATA AND P. TACAMAHACA PULPED TOGETHER]. J. Organ. Chem. 26(2): 550-2. 8 refs.

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Jayme, G. 1951. UBER DIE BEDEUTUNG DES ZUGHOLZANTEILS IN PAPPELHOLZERN. [THE SIGNIFICANCE OF TENSION-WOOD IN POPLAR.] Holz Roh- u. Werkstoff 9(5): 173-5. [G.g.]

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From abstr. in Holzforschung, Berlin 14(1): 26. 1960. [G.]

Pearl, I. A., Beyer, D. L., and Hickey, E. E. 1958. STUDIES ON THE CHEMISTRY OF ASPENWOOD. II. LIGNANS FROM ASPEN SPENT SULFITE LIQUOR. J. Organ. Chem.23(5): 705-6. 5 refs. [Cf. Pearl and Beyer, 1957, P. tremuloides, 813.]

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Traynard, P., and Eymery, A. 1955. DELIGNIFICATION DES VEGETAUX PAR LES SOLUTIONS HYDROTROPIQUES. [DELIGNIFICATION OF PLANT MATERIAL WITH HYDROTROPIC SOLUTIONS.] Holzforschung, Berlin 9(6): 172-7. 41 refs. [F.f.g.]

———— and Eymery, A. 1956. DELIGNIFICATION PAR LES SOLUTIONS HYDROTROPIQUES. II. ETUDE DES LIGNINES HYDROTROPIQUES. [DELIGNIFICATION BY MEANS OF HYDROTROPIC SOLUTIONS. II. INVESTIGATION OF HYDROTROPIC LIGNINS.] Holz- forschung, Berlin 10(1): 6-11. 7 refs. [F.f.g.]
A thorough chemical analysis of a hydrotropic lignin from poplar wood seems to indicate that it is a homogeneous preparation. The hypothesis is advanced that a diketone is present in its formula.

———— and Robert, A. 1952. EXTRACTION DE LA LIGNINE DU PEUPLIER PAR L'ACIDE NITRIQUE. [EXTRACTING LIGNIN FROM POPLAR BY NITRIC ACID.] Bull. Soc. Chim. France 19(7/8): 746-50. 11 refs. [F.f.]

813.13

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———— and Schenck, U. 1948. UBER DIE SCHNELLBESTIMMUNG DES CELLULOSEGEHALTES VON PAPPELHOLZERN. [A RAPID METHOD OF DETERMINING THE CELLULOSE CONTENT OF POPLAR WOOD.] Papier, Darmstadt 2(17/18): 323-7. 17 refs. [G.g.]

813.2

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Jayme, G., and Rothamel, L. 1944. COMPOSITION OF THE EXTRACTIVES OBTAINED FROM BLACK POPLARWOOD AND OF THOSE FOUND IN THE RESULTING SULPHITE AND SULPHATE PULPS. Cellulosechemie 2: 88-96. Chem. Abstr. 40: 2980. 1946.

Roudier, A., Roudier, A., and Eberhard, L. 1952. L'ESSAI D'EXTRACTION A L'EAU AU COURS DE L'ANALYSE DES MATIERES PREMIERES CELLULOSIQUES. [EXPERIMENT IN WATER-EXTRACTION DURING THE ANALYSIS OF CELLULOSIC RAW MATERIALS.] APPENDICE. EXTRACTION DU BOIS DE PEUPLIER (× POPULUS ROBUSTA SCHNEIDER) PAR L'EAU A 140°. [APPENDIX. EXTRACTION OF WOOD OF × P. ROBUSTA WITH WATER AT 140° C.] Memorial des Services Chimiques de l'Etat, Paris 37(2): 109-32. 21 refs. [F.f.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Jayme, G. 1947. UBER DEN EINFLUSS DER SORTE UND DES STANDORTES AUF DIE CHEMISCHE ZUSAMMENSETZUNG UND EIGNUNG VON PAPPELHOLZERN ZUR ZELLSTOFFGEWINNUNG. [THE INFLUENCE OF SPECIES AND SITE ON THE CHEMICAL COMPOSITION OF POPLAR WOOD AND ITS SUITABILITY FOR PULPING.] Papier, Darmstadt 1(9/10): 182-90. 15 refs. [G.g.]

Kennedy, R. W., and Smith, J. H. G. 1959. THE EFFECTS OF SOME GENETIC AND ENVIRONMENTAL FACTORS ON WOOD QUALITY IN POPLAR. Pulp Paper Mag. Can. 60(2): T35-T36. 9 refs. Also in Res. Note Fac. For. Univ. B. C. No. 19.

815.2

Johnson, L. P. V. 1942. STUDIES ON THE RELATION OF GROWTH RATE TO WOOD QUALITY IN POPULUS HYBRIDS. Canad. J. Res. 20, Sec. C: 28-40. Bblg.

82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD: GENERAL

Fenchel, U. 1958. UNTERSUCHUNGEN UBER DIE ENTRINDUNGSFAHIGKEIT VON PAPPELHOLZ BEI THERMISCHER VORBEHANDLUNG UND NACHFOLGENDER TROMMELUNG. [EASE OF BARKING OF POPLAR IN DRUM BARKING AFTER HOT-WATER TREATMENT.] Wochenblatt fur Papierfabrikation, Biberach 86(18): 793-6. [G.g.]
Freshly felled poplar was drum-barked in 45 min. after receiving 4 hours' hot-water treatment at 90° C., whereas untreated poplar took 2 hours to bark.

825.71

Pahlitzsch, G., and Mehrdorf, J. 1963. [CHIP MANUFACTURE WITH FLAT-DISK CHIPPERS. 4. CHIPPING POPLAR AS COMPARED WITH PINE.] Holz Roh- u. Werkstoff 21(4): 144-9. 5 refs. [G.g.e.]

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Croce. 1932. USE AND EXPLOITATION OF POPLARS. Biol. Abstr. 6: 17048.

Houtzagers, G. 1937. POPLAR AS A UTILITY WOOD. Ned. Boschb.-Tijdschr. 10(8): 289-96. [Du.]

Tessier. 1932. NOTE ON THE GENUS POPULUS USES AND QUALITY OF WOOD. Rev. Eaux For. 70: 288.

Thornewill. 1924. USES IN SOUTH AFRICA. J. Oxf. Univ. For. Soc. 5: 30.

83/86

[Germany: Holzzucht] 1961. PAPPELHOLZVERWERTUNG-FLURHOLZVERWERTUNG. [THE UTILIZATION OF POPLAR WOOD AND OF POPLAR OR OTHER WOOD GROWN OUTSIDE THE FOREST.] Holzzucht, Reinbek 15(3/4): 11-46. Many refs. [G.]

832.2

Liese. 1932. USE OF POPLAR WOOD IN PLYWOOD MAKING. Forstl. Rundschau 5: 47.

Millan, T. 1943. SWELLING OF POPLAR VENEER DURING AND AFTER PHENOLIC-RESIN IMPREGNATION. Plastics Trends 3(3): 5-6. Chem. Abstr. 37: 3528.

Paraschiv, E., Oradeanu, T., Marinescu, D., and others. 1961. [THE MANUFACTURE OF PLYWOOD AND BLOCKBOARDS FROM POPULUS × REGENERATA CV. CELEI, P. DELTOIDES VIRGINIANA CV. CETATE AND P. × MARILANDICA.] Stud. Cerc. Inst. Cerc. For., Bucuresti 22B: 209-31. 31 refs. [Rum.russ.g.e.]
Pilot- and semi-industrial-scale experiments indicated that only the first of these three poplars is suitable for this purpose; logs of less than 35 cm. diameter are unsuitable, but larger logs peel well and no difficulties arose over gluing or pressing.

Regnier, R. 1952. IMPORTANCE DES DEGATS DE LA MINEUSE DU CAMBIUM DU PEUPLIER POUR L'INDUSTRIE DU DEROULAGE. [THE IMPORTANCE OF DAMAGE BY A CAMBIUM BORER IN POPLAR TO THE VENEER INDUSTRY.] Trans. 9th Int. Congr. Ent., Amsterdam 1951 (1): 711-4. 7 refs. [F.e.]

Rostler, G. 1943. STRESS-STRAIN IN COMPRESSION OF RESIN-BONDED PLYWOODS. Brit. Plastics 14(165): 534.

[U.S.A.: For. Prod. Lab.] 1957. VENEER CUTTING AND DRYING PROPERTIES. ASPEN AND HYBRID POPLAR. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 1766-13, 4 pp. 7 refs.
Populus tremuloides, P. grandidentata, P. charkowiensis × P. robusta, P. charkowiensis × P. caudina.

832.3

Anonymous. 1925. POPULUS FOR MATCHES. Rep., For. Dep., Union Sth. Afr. 1924/25: 23.

[Austria: Int. Holzmarkt] 1954. DIE PAPPEL IN DER ZUNDHOLZ-INDUSTRIE. [POPLAR FOR MATCH MANUFACTURE.] Int. Holzmarkt 45(2): 16-7. [G.]
Discusses the relative merits as regards chemical and mechanical properties and ease of manufacture of spruce and different poplar species.

833 TIMBER IN BUILDINGS AND ENGINEERING STRUCTURES (MANUFACTURE AND USE)

Bell, L. E., and Jefferson, C. H. 1944. USING JACK PINE AND POPPLE FOR FARM BUILDING. Ext. Bull. Mich. St. Coll. No. 255, 23 pp. Bblg.

835 INDUSTRIAL AND DOMESTIC WOODWARE (MANUFACTURE AND USE)

Anonymous. 1936. POPLAR WOOD FOR STOPPERS. Dtsch. Forstw. 18(71): 876. [G.]

Kullmann. 1936. [MARXEN STOPPERS—CORKS OF GERMAN WOOD, MADE OF POPLAR AND ASPEN WOOD; SUPERIOR TO CORK IN FREEDOM FROM CONTAMINATION AND IN DURABILITY.] Holztechnik 16(21): 348-350. [G.]

836.1

Najera y Angulo, F. 1955. L'UTILISATION DU BOIS DE PEUPLIER EN ESPAGNE: SON EMPLOI EN EBENISTERIE. [THE UTILIZATION OF POPLAR WOOD IN SPAIN: ITS USE IN CABINET-MAKING.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 3, 7 pp. [F.]

838.7

Winter, H. 1956. PAPPELHOLZ ALS WERKSTOFF IM FLUGZEUGBAU UND LEICHTBAU. [POPLAR WOOD AS CONSTRUCTION MATERIAL IN AIRCRAFT AND OTHER LIGHT CONSTRUCTIONS.] Abstr. in Holz-Zbl. 82(30): 392. [G.]
Contains a table of various strength properties for poplar wood of 12% m.c. It is suitable for cores of plywoods and sandwich constructions, and for parts of gliders, light aircraft, etc., not subject to heavy stresses.

839.1

Giordano, G. 1957. LE BOIS DE PEUPLIER AU SERVICE DE LA MODE FEMININE. [POPLAR WOOD IN THE SERVICE OF WOMEN'S FASHIONS.] Rev. Bois Appl. 12(6): 16-8. [F.]
Describes the manufacture of very long, narrow shavings from the wood of American poplar hybrids, used in Italy for making plaited articles (mainly hats).

Najera Angulo, F. 1959. SECCION DE MADERAS. CLASES DE MADERA MAS CONVENIENTES PARA SU EMPLEO COMO ELEMENTO COALESCENTE DEL AGUA QUE CONTINEN LA GASOLINA Y OTROS CARBURANTES. [TIMBER SECTION. TYPES OF WOOD SUITABLE FOR USE AS A WATER ABSORBENT IN PETROL AND OTHER FUELS.] An. Inst. For. Invest. Exp., Madrid 31(4): 51-3. [Span.]

Tronco, G. 1961. LA MODA SI FA COL PIOPPO. [FASHION MAKES USE OF POPLAR.] Ital. Agric. 98(6): 575-83. [It.]
An account of the chip hat industry of Carpi, which chiefly uses poplar wood specially grown for the purpose and felled at not more than 8 years old. The clone "488 B" is considered the most suitable on account of its erect cylindrical stem and freedom from tension wood.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES.

844 ATTACK BY PLANT ORGANISMS

Martinez, J. B. 1955. HONGOS Y ENFERMEDADES DE LOS CHOPOS EN ESPANA, INCLUYENDO PUDRICIONES Y ALTERACIONES CROMOGENAS DE SU MADERA. [FUNGUS AND OTHER DISEASES OF POPLARS IN SPAIN, INCLUDING WOOD ROTS AND STAINS.] [Pap.] 8th Sess. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 8, 17 pp. [Span.]
Lists the causal organisms, with literature references.

844.1

Rogister, J. 1955. HET VERBLAUWEN VAN HOUT. [BLUE STAIN IN WOOD.] Meded. Lab. Houttechnol., Gent No. 13, 78 pp. 110 refs. [Flem.flem.f.e.g.]

844.2

Fritz, C. W. 1954. DECAY IN POPLAR PULPWOOD IN STORAGE. Canad. J. Bot. 32(6): 799-817. 17 refs.

Lohwag, K. 1959. HOLZFAULEN AN PAPPELHOLZ. [WOOD-ROTTING FUNGI ON POPLAR.] Istanbul Univ. Orm. Fak. Derg. 9A(1): 1-10. 1 ref. [G.turk.g.turk.]
Discusses damage by Fomes igniarius on standing trees, and by Stereum purpureum, Polystictus hirsutus, and Schizophyllum commune on logs in a storage depot. Preventive and control measures are also discussed.

844.4

Barbey, A. 1935. COMMENT LUTTER CONTRE L'EXTENSION DES DOMMAGES TECHNIQUES DU BOIS PEUPLIER. [HOW TO LIMIT THE SPREAD OF INSECT AND FUNGAL DAMAGE IN POPLAR TIMBER.] Bull. Com. For., Paris No. 64: 473-79. [F.]

85 "GRADING" OF WOOD AND WOOD PRODUCTS

852.16

[International: FAO/Int. Poplar Comm.] 1955. BLACK HEARTWOOD: REPORT OF THE NATIONAL POPLAR COMMISSION OF THE NETHERLANDS. [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/78-A, 2 pp. [E.]
This defect is found mainly in poplars grown on excessively wet sites, e.g., with stagnant groundwater. Heartwood of × Populus gelrica and P. deltoides subsp. missouriensis is generally lighter in color than that of × P. marilandica, × P. serotina, and especially P. robusta. For the most part the defect does not cause serious loss in industry.

———— 1955. COEUR NOIR DU PEUPLIER. [BLACK HEART IN POPLAR.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/78-C, 2 pp. [F.]
A report of the Belgian Poplar Commission on the results of their inquiry. Most users of poplar wood do not consider black heart worthy of a mention, but the Union Allumettiere considers it a serious defect, resulting either in matches and match boxes of inferior quality, or by avoiding it, an unsatisfactory output per unit of timber.

Jayme, G., and Harders-Steinhauser, M. 1953. ZUGHOLZ UND SEINE AUSWIRKUNGEN IN PAPPEL- UND WEIDENHOLZ. [TENSION WOOD AND ITS EFFECTS IN POPLAR AND WILLOW WOOD.] Holzforschung, Berlin 7(2/3): 39-43. 10 refs. [G.g.e.]

———— Harders-Steinhauser, M., and Mohrberg, W. 1951. EINFLUSS DES ZUGHOLZANTEILS AUF DIE TECHNOLOGISCHE UND CHEMISCHE VERWENDBARKEIT VON PAPPELHOLZERN. [EFFECT OF THE TENSION WOOD CONTENT ON TECHNOLOGICAL AND CHEMICAL UTILIZABILITY OF POPLAR WOOD.] Papier, Darmstadt 5(19/20; 21/22; 23/24): 411-7; 445-7; 504-7. 18 refs. [G.g.]

———— Harders-Steinhauser, M., and Mohrberg, W. 1951. INFLUENCE OF THE TENSION-WOOD FRACTION ON THE CHEMICAL AND TECHNOLOGICAL USEFULNESS OF POPLAR. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 1683, 13 pp. 1952. 11 refs.
Transl. by M. Slade from Papier, Darmstadt 5(19/20): 411-7.

Klauditz, W. 1958. ZUM CELLULOSE- UND ZUGHOLZGEHALT DES HOLZES VON PAPPELN. [THE CELLULOSE AND TENSION-WOOD CONTENT OF POPLAR WOOD.] Holzforschung, Berlin 11(5/6): 158-69. 38 refs. [G.g.e.]

Peace, T. R. 1955. BLACK HEARTWOOD. [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/78-B, 2 pp. [E.]
Reports on a preliminary inquiry on the occurrence of black heartwood in poplar grown in Britain. There appears to be evidence that trees grown on low, wet sites are particularly subject to this defect. On the other hand, trees grown in Herefordshire and Shrepshire, on Old Red Sandstone, produce particularly pale heartwood. × P. regenerata is said to be particularly subject to dark heart.

852.18

Paclt, J. 1953. ODLUPCIVOST'TOPOL'OV A JEJ POVODCA. [RING-SHAKES IN POPLARS AND THEIR CAUSE.] Pol'ana 9(11): 255-6. [Slovak.]
In addition to Trichotecium roseum, preliminary studies have isolated a so far unidentified parasite Deuteromyces (Sphaeropsidales?).

853 GRADING OF WOOD IN THE ROUGH

Meiden, H. A. van der. 1961. WENSEN VAN DE HOUTINDUSTRIE TEN AANZIEN VAN DE TEELT VAN POPULIER. [REQUIREMENTS OF THE TIMBER INDUSTRY AND POPLAR CULTIVATION.] Ned. Boschb.-Tijdschr. 33(5): 126-30. 4 refs. [Du.du.e.]
Discusses briefly requirements of various industries (e.g., veneer, match, sawmilling, and clog) as regards clones (Populus × marilandica is preferred for matchboxes), pruning, a bark spot probably physiological in nature, etc., and stresses the need for grading rules. [Cf. Meiden, 1957, Populus sp., 245.13.]

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Anonymous. 1927. POPLARS FOR PULP WOOD. Nature 119: 869.

———— 1930. HYBRID POPLARS AND PULP PRODUCTION. Nature 126: 148.

Brecht, W. 1959. GROUNDWOOD AND CHEMIGROUNDWOOD FROM EUROPEAN POPLARWOOD [UNSPECIFIED]. Tappi 48(8): 664-9. 16 refs.
Reviews and discusses previous European work, and presents data on laboratory tests using various "mild" (notably the Weisshuhn) and "strong" (the Libby-O'Neill) chemical pretreatments. Reference is made to pioneer work being done in Canada and the U.S.A.

Bustamente Ezpeleta, L., Pedro Abello, S. de, Barbadillo Gomez, P., and others. 1961. [STUDY OF DIFFERENT POPLARS AS RAW MATERIAL FOR PULP PRODUCTION.] An. Inst. For. Invest. Exp., Madrid 33(6): 103-33. 25 refs. [Span.]

Komaroff. 1933. POPLAR AND ITS UTILIZATION FOR CELLULOSE SUPPLY. Forstl. Rundschau 6. 197.

McKee. 1931. POPLARS FOR CELLULOSE: PRODUCTION EXPERIMENTS. Biol. Abstr. 5: 11766.

861.0

Bialoblocki, B., and Borninski, J. 1954. GROUNDWOOD MANUFACTURE FROM POPLAR. Przeglad. Papierniczy, Lodz 10: 168-72. [Pol.]
From abstr. in Chem. Abstr. 49(8): 5830. 1955.

Bray, M. W., and Paul, B. H. 1942. PULPING STUDIES ON SELECTED HYBRID POPLARS. Paper Tr. J. 115(16): 33-8. Abstr. in Bull. Inst. Pap. Chem. 13:115-6.

Brown, C. L., Saeger, G., and Weiner, J. 1957. CONSTITUTION AND PULPING OF ASPEN AND POPLAR WOODS. Bibliographic Series, Inst. Pap. Chem., Appleton, Wis. No. 184, 120 pp.
Contains 317 abstracts arranged alphabetically under authors; in preparing the bibliography, Bulletins of the Institute of Paper Chemistry (Library Notes) and Chem. Abstr. up to and including 1956 and TAPPI bibliographies between 1900 and 1955 were examined. References to breeding have been omitted.

Burki, M. 1957. L'UTILISATION DE PEUPLIER DANS L'INDUSTRIE SUISSE DU PAPIER. [THE USE OF POPLAR IN THE SWISS PAPER INDUSTRY.] Schweiz. Z. Forstw. 108(1): 50-2. [F.]
The present demand is estimated at 37,000 cu.m., of which ca. 2,000 are supplied by Switzerland. Owing to the technical superiority of conifer pulps, demand will always be limited in Switzerland despite the greater cheapness of hardwoods for pulping, as Swiss industry is geared to quality, but a market exists for sound straight wood, not less than 10 cm. thick at the end, of Populus nigra, P. alba, P. "canadensis," and, above all, P. tremula.

Chidester, G. H., Seidl, R. J., and Schafer, E. R. 1955. EXPERIMENTS IN THE MANUFACTURE OF NEWSPRINT FROM COTTONWOOD AND WILLOW. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 2028, 10 pp. 5 refs.
Results of comprehensive pulping tests indicate that newsprint can be manufactured from a blend of cottonwood groundwood and semi-bleached softwood sulphate pulp in the usual proportions. Willow groundwood gave paper of good quality when forming up to 30% of the furnish.

Clark, D. J. 1957. THE USE OF COTTONWOOD FOR PULP. Tappi 40(1): 133A-135A. 5 refs.

Craig, K. A. 1949. THE USE OF VARIOUS POPLAR MECHANICAL OR GROUNDWOOD PULPS CONTAINING ROT IN HIGH-GRADE BOOK PAPER. U. S. Patent No. 2,474,034, June 21, 1949. Chem. Abstr. 43(17): 6826. 1949.

[France] 1951. ESSAIS DE FABRICATION DE PATES A PAPIER A L'AIDE DE BOIS D'EMBALLAGE (PEUPLIER): (PROCEDES NITRO-SODIQUES). [EXPERIMENTAL PULPING OF POPLAR WOOD FROM USED CRATES BY NITRIC-ACID/SODA PROCESSES.] Rapp. Fonds For. Nat. Jan./Dec. 1950, Annexe 11 1951: 6-8. [F.]

Jayme, G. 1948. POPLAR WOOD FOR PULP MANUFACTURE: FACTORS AFFECTING SUITABILITY. Industr. Chem., Lond. 24(283): 545-9. 25 refs.

———— 1955. L'ESAME DEI DIVERSI LEGNI DI PIOPPO COME MATERIA PRIMA PER LA PREPARAZIONE DELLA CELLULOSA. [THE EXAMINATION OF THE WOOD OF SEVERAL SPECIES OF POPLAR AS RAW MATERIAL FOR PULP.] Cellulosa e Carta 6(3): 6-21. 25 refs. [It.it.]
Reviews in detail, with experimental data, the work of the author and others, on the physical, mechanical, and chemical properties of poplar wood and their effect on pulping quality, including methods of analysis.

Jayme, J., Hindenburg, K. -G., Harders-Steinhauser, M., and Branscheid, F. 1943. UBER DIE EIGNUNG EIN-UND ZEHNJAHRIGEN PAPPELHOLZES ZUR ZELLSTOFFGEWINNUNG. [ON THE SUITABILITY FOR PULP MANUFACTURE OF 1- AND 10-YEAR-OLD POPLAR WOOD.] Holz 6(1): 1-16. Bblg. [G.g.]

Klauditz, W., and Berling, K. 1951. UNTERSUCHUNGEN UND FESTSTELLUNGEN UBER DIE EIGNUNG EINIGER SCHNELLWUCHSIGER HOLZARTEN ZUR HERSTELLUNG VON PAPIER, ZELLSTOFFEN, HOLZFASER- UND HOLZSPANPLATTEN. [RESEARCH AND CONCLUSIONS ON THE SUITABILITY OF SOME FAST-GROWING TREE SPECIES FOR THE MANUFACTURE OF PAPER, PULPS, FIBREBOARDS, AND CHIPBOARDS.] Tagungsbericht des Vereins fur Technische Holzfragen, Braunschweig, 1951: 23-39. 19 refs. [G.]

Krzysik, F., and Gonet, B. 1954. POPLAR AS A RAW MATERIAL FOR PULP AND PAPER. Przeglad Papierniczy, Lodz 10: 161-8. [Pol.]
From abstr. in Chem. Abstr. 49(8): 5830. 1955.

Patt, K. F. 1961. PAPPEL UND BAUMWEIDE ALS FASERHOLZ. [POPLARS AND TREE WILLOWS AS PULPWOOD.] Forstarchiv 32(6): 122-4. 9 refs. [G.g.]

Schepp, R. 1956. DIE VERWERTUNGSMOGLICHKEITEN DES PAPPELHOLZES IN DER ZELLSTOFF- UND PAPIERINDUSTRIE. [POTENTIAL USES OF POPLAR WOOD IN THE PULP AND PAPER INDUSTRIES.] Abstr. in Holz-Zbl. 82(30): 392. [G.]
Contains data on strength properties of unbleached sulphite and sulphate pulps from P. tremula and percents of poplar pulp usable in paper manufacture. As large-scale use will require special plant, sufficient steady supplies must be assured. Low pulp yield/cu.m. is a drawback, affecting prices.

Toth, L. B. 1950. THE UTILIZATION OF FAST-GROWING FOLIAGE TREES, PARTICULARLY POPLARS, IN THE PAPER AND PULP MANUFACTURING INDUSTRY. Papir Nyovdatechnika 2(6): 21-3.
From Hung. Tech. Abstr. 1951(4): 17. Pine and poplar may be used together in pulping. Poplar should be stored longer because of its higher water content. Pulp yield from poplar is affected by soil conditions. The cellulose content decreases towards the top of the tree. Up to 17 years of age the cellulose content increases, and then starts to decrease.

Vamos, G. 1963. THE UTILIZATION OF POPLAR IN HUNGARY. Svensk PappTidn. 66(8): 291-7. [E.e.f.g.]
Gives data on the forest area percent under poplars, the chemical composition of some of the more important species (Populus alba, P. tremula, P. nigra, P. × euramericana, P. × robusta, P. × marilandica, and P. × serotina), and characteristics of poplar pulps (groundwood and chemical) and their uses, and discusses the potential increase in the use of poplars for pulping.

861.11

Brecht, W., and Pulst, S. 1956. DIE HERSTELLUNG VON CHEMISCHEN SCHLIFFEN AUS PAPPELHOLZ. [CHEMICAL GROUNDWOOD FROM POPLAR.] Holz Roh- u. Werkstoff 14(6): 234-41. 6 refs. [G.g.]

Craig, K. A. 1949. BLEACHING POPLAR GROUNDWOOD. U. S. Patent No. 2,474,034, June 21, 1949. Abstr. in Paper Tr. J. 129(21): 31. 1949.

861.12

Rozmej, Z., and Kowalski, J. 1960. WSTEPNE BADANIA NAD OTRZYMANIEM MASY POLCHEMICZNEJ Z TOPOLI. [PRELIMINARY INVESTIGATIONS ON OBTAINING SEMI-CHEMICAL PULPS FROM POPLAR WOOD.] Przeglad Papierniczy, Lodz 16(5): 129-31. [Pol.]
From abstr. in Pol. Tech. Abstr. No. 1(41):6858. 1961. Describes laboratory studies on neutral sulphite semi-chemical pulps from poplar wood. It was found that semi-chemical pulps with a yield of ca. 85% were not inferior in strength properties to unbleached sulphite pulps from spruce.

861.12/16

Molnar, L., and Morvay, S. 1952. VIZSGALATOK NYARFACELLULOZ ELOALLITASAVAL KAPCSOLATBAN. [INVESTIGATIONS ON POPLAR PULP.] Papir- es Nyomdatechnika, Budapest 4(2): 18-20. [Hung.]
From Hung. Tech. Abstr. 5(1): 82. 1953.

861.15

Kerr, W. D., and Hart, J. S. 1957. HIGH YIELD SULPHITE PULPING. PART 8. POPLAR—PART II. Pulp Paper Mag. Can. 58(4): 139-45. 4 refs.

Parkinson, L. 1939. SEASONING AS A CONTROL OF PITCH IN POPLAR SULPHITE PULP. Paper Mill & Wood Pulp News 62(5): 16-18, 20.

861.19

Pearl, I. A., and Beyer, D. L. 1959. SEPARATING LIGNOSULFONATES FROM CARBOHYDRATES IN ASPEN SPENT SULFITE LIQUOR BY ION EXCHANGE. For. Prod. J. 9(10): 381-3. 8 refs.

862.2

Klauditz, W., and Stegmann, G. 1958. UBER DIE EIGNUNG VON PAPPELHOLZ ZUR HERSTELLUNG VON HOLZSPANPLATTEN. [SUITABILITY OF POPLAR WOOD FOR THE MANUFACTURE OF CHIPBOARDS.] Holzforschung, Berlin 11(5/6): 174-9. 11 refs. [G.g.e.]
Discusses the effect of the low density of poplar wood on the properties of the resulting chipboard, compared with those of chipboards made from spruce, birch, and beech. Poplar may be considered a suitable raw material for chipboard manufacture.

Lazar, L., and Hadnagy, J. 1962. [STUDIES ON PARTICLE FORMATION WITH POPLAR, BEECH, AND QUERCUS CERRIS.] Faipari. Kutatasok., Budapest 1962(1): 3-64. [Hu.]
Describes the comminuting and screening of chips and discusses their suitability for making particle board, with tabulated and graphed data comparing the physical and mechanical properties of board made from the species examined.

863 WOOD HYDROLYSIS. SACCHARIFICATION

Fries, K. W. 1946. EASILY HYDRATING PULP FROM POPLAR WOOD. Paper Tr. J. 122 (21): 43-4. Bblg.

89 OTHER ("MINOR") FOREST PRODUCTS

892.49

Pearl, I. A. 1963. ASPEN BARK AS A SOURCE OF ORGANIC CHEMICALS. For. Prod. J. 13(3): 122-3. 10 refs.
Briefly summarizes results of research on the constituents of the bark of Populus tremuloides (used commercially for the extraction of salicin) and P. grandidentata.

———— Beyer, D. L., Laskowski, D., and others. 1960. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. III. THE ALKALINE HYDROLYSIS OF BARKS OF SEVERAL SPECIES OF THE GENUS POPULUS. Tappi 43(9): 756-8. 8 refs.

———— Darling, S. F., DeHaas, H., and others. 1961. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. IV. PRELIMINARY EVALUATION FOR GLUCOSIDES OF BARKS OF SEVERAL SPECIES OF THE GENUS POPULUS. Tappi 44(7): 475-8. 11 refs.

[U.K.: Gardeners' Chron.] 1954. BARK FIBRE AND SAWDUST. Gardeners' Chron., Lond. (Ser. 3) 135(3499): 41.
Mentions a pulverized bark product made from poplar bark fibre by a firm of match manufacturers, which has shown itself promising for mulching, as a compost component, a bulb-growing medium, etc.

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

906 DIRECT ECONOMIC SIGNIFICANCE OF FORESTS

Albisetti, C. 1941. LE PEUPLIER: DE SON IMPORTANCE FORESTIERE ET ECONOMIQUE. [THE POPLAR: ITS FORESTRY AND ECONOMIC IMPORTANCE.] J. For. Suisse 92(8): 173-5. [F.]

94 METHODS TO IMPLEMENT FOREST POLICY

945 ADVISORY SERVICES, PUBLICITY, EDUCATION, RESEARCH

945.4

Allegri, E. 1957. RAPPORT AU GOUVERNEMENT DE L'IRAN SUR L'ETABLISSEMENT D'UN CENTRE DE RECHERCHES FORESTIERES. [REPORT TO THE GOVERNMENT OF IRAN ON THE SETTING UP OF A FOREST RESEARCH CENTER.] Expanded Technical Assistance Program, FAO, Rome FAO Report No. 541, 60 pp. [F.]
Includes an appendix (40 pp.) on poplar breeding and research in Iran.

Camaiti, M. A. 1957. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES. ITALIE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. ITALY.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-K, 43 pp. 104 refs. [F.]
Includes data on organization, membership, and activities (research, breeding, planting programs), a bibliography, and annexes

on the exchanges of genetical material by the Institute at Casale Monferrato, the statutes of the (co-operative) poplar protection societies, and extent, density, etc., of poplar plantations in the Po Valley.

Elorrieta, J. 1957. INFORMES SOBRE LAS ACTIVIDADES DE LAS COMISIONES NACIONALES, ESPANA. INVESTIGACIONES SOBRE LOS CHOPOS CULTIVADOS EN ESPANA. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. SPAIN. RESEARCH ON POPLARS CULTIVATED IN SPAIN.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-F. Add. 2, 2 pp. [Span.]
Includes a report on heterosis observed in Populus tremula × P. alba and P. tremula × P. alba var. bolleana hybrids, in contrast to the experience of W. Wettstein and C. Heimburger, who obtained poor results with the first combination.

Eren, T. 1957. (1) RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES. TURQUIE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. TURKEY.] (2) THE IMPORTANCE OF POPLAR FOR TURKEY. [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-M; No. FAO/CIP/86-M. Add. 7 pp.; 5 pp. 5 refs. [F.;E.]
(1) Covers the activities of the Commission since its inception in 1954, including the plans for the erection of a Near-East Poplar Research Station, well under way. (2) Surveys present conditions and possibilities of poplar cultivation for the regions of Thrace, Mormora, the Aegean, Mediterranean, Black Sea, and Central and South Anatolian areas including the competing claims of eucalypts.

———— 1958. FONDATION ET TRAVAUX DE L'INSTITUT DE POPULICULTURE POUR LA TURQUIE ET LE PROCHE-ORIENT. [FOUNDATION AND PROGRAM OF WORK OF THE POPLAR INSTITUTE FOR TURKEY AND THE NEAR EAST.] [Docum.] 14th Sess. Stand. Exec. Comm. Int. Poplar Comm., Rome 1958 No. FAO/CIP/CP/19, 9 pp. [F.]
Describes the progress made at the site of the future institute at Izmit, including planting work completed, and future plans, listing the poplar varieties available at the experimental nurseries at Izmit and Ankara as 1- and 2-year-old plants and 1-year cutback rooted cuttings.

Gaillard, E. 1957. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES. SUISSE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. SWITZERLAND.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-C, 15 pp. 8 refs. [F.]
A review of the activities of the last 10 years, including a list of clones at the poplar garden at Glanzenberg.

Gunther, H. 1955. BERICHT UBER DEN STAND DER PAPPELFORSCHUNG IN DEN DEUTSCHEN DEMOKRATISCHEN REPUBLIK. [REPORT ON PRESENT POSITION OF POPLAR RESEARCH IN THE D.D.R.] Arch. Forstw. 4(7/8): 662-88. 9 refs. [G.]
Given before the Forestry Section of the Deutsche Akademie der Landwirtschaftwissenschaften Berlin, March 10, 1955.

Herbignat, A. 1957. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE. 1955. BELGIQUE. [PROGRESS REPORTS OF NATIONAL POPLAR COMMISSIONS 1955. BELGIUM.] Docum. Int. Poplar Comm. No. FAO/CIP/82-H, 11 pp. [F.]
Lists varieties tried at the Populetum of Egenhoven and some growth data from trial plots, export and import statistics, etc.

Houtzagers, G., and Burger, F. W. 1956. PROGRESS REPORT OF NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1955: NETHERLANDS. [Pap.] Int. Poplar Comm. No. FAO/CIP/82-D, 8 pp. 11 refs.

[International: FAO/Int. Poplar Comm.] 1955. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1954: ALLEMAGNE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: GERMANY.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-F, 8 pp. [F.]

———— 1955. REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: NETHERLANDS. [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-G, 9 pp. [E.]

———— 1955. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1954: ITALIE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: ITALY.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-H, 10 pp. [F.]

———— 1955. REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: TURKEY. [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-I, 10 pp. [E.]

———— 1955. REPORTS OF THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: SWEDEN. [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-J, 2 pp. [E.]

———— 1955. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1954: ESPAGNE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1954: SPAIN.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K, 7 pp. [F.]

———— 1956. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1955. FRANCE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1955: FRANCE.] [Pap.] Int. Poplar Comm. No. FAO/CIP/82-A, 7 pp. 5 refs. [F.]

———— 1956. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1955. SUISSE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1955: SWITZERLAND.] [Pap.] Int. Poplar Comm. No. FAO/CIP/82-B, 11 pp. [F.]

———— 1956. PROGRESS REPORT OF NATIONAL COMMISSIONS FOR THE YEAR 1955. EGYPT. [Pap.] Int. Poplar Comm. No. FAO/CIP/82-C, 2 pp. [E.]
Contains notes on poplar varieties introduced and on some local varieties.

———— 1957. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES DEPUIS 1947 OU DEPUIS LEUR CREATION. RAPPORT DU SECRETARIAT. [PROGRESS REPORTS OF THE NATIONAL [POPLAR] COMMISSIONS SINCE 1947 OR SINCE THEIR FOUNDATION. SECRETARIAT REPORT.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86, 23 pp. [F.]
Summarizes reports of 10 European countries.

———— 1957. RAPPORT D'ACTIVITE DES COMMISSIONS NATIONALES. ESPAGNE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. SPAIN.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-F; No. FAO/CIP/86-F Add. I, 8 pp.; 6 pp. [F.]
A report on the organization and activities of the Commission since its inception in 1952, plus a separate account of the activities for the year 1956.

———— 1957. RAPPORTS D' ACTIVITE DES COMMISSIONS NATIONALES. YOUGOSLAVIE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. YUGOSLAVIA.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-H, 19 pp. 44 refs. [F.]
Covers organizational activities since its inception in 1955.

———— 1957. RAPPORTS D' ACTIVITE DES COMMISSIONS NATIONALES. ALLEMAGNE. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. GERMANY.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-J, 28 pp. 15 refs. [F.]
Contains a general account of organization and activities, with annexes on: the aims and activities of the German Poplar Society; the production of poplar pulpwood (F. Bauer) [cf. Bauer, 1956, Populus sp., 238]; biological research of the year 1956 carried out at Bruhl, Hann. Nunden, Munich, Schmalenbeck, and Stuttgart (R. Muller), and at Freiburg i. Br. (F. Bauer). [Cf. Bauer, 1956, Populus sp., 176.1.]

———— 1958. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1957. [PROGRESS REPORTS OF THE NATIONAL [POPLAR] COMMISSIONS FOR 1957.] [Docum.] Int. Poplar Comm. Nos. FAO/CIP/93-B-L & O; 4 pp.; 7 pp.; 22 pp.; 2 pp.; 4 pp.; 7 pp.; 6 pp.; 12 pp.; 13 pp.; 10 pp.; 2 pp.; 4 pp. [F.] Nos. FAO/CIP/93-A, M, & N; 7 p.; 3 pp.; 1 p. [E.]
Switzerland; Spain; Italy; Austria; Greece; Turkey; Morocco; Yugoslavia; Germany; France; Lebanon; Syria; United Kingdom; Argentina; and Sweden.

———— 1959. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES DU PEUPLIER. PERIODE 1958. TURQUIE. [REPORTS ON THE ACTIVITIES OF NATIONAL POPLAR COMMISSIONS FOR 1958: TURKEY.] [Docum.] 10th Sess. Int. Poplar Comm., Italy 1959 No. FAO/CIP/95-N, 20 pp. [F.] [Cf. Eren, 1957 and 1958, this subject classification.]

———— 1959. RAPPORTS D'ACTIVITES DES COMMISSIONS NATIONALES DU PEUPLIER. REPUBLIQUE ARABE UNIE: REGION SYRIENNE. [REPORTS OF THE ACTIVITIES OF THE NATIONAL POPLAR COMMISSIONS: SYRIA.] [Docum.] 10th Sess. Int. Poplar Comm., 1959 No. FAO 59/7/5626, 8 pp. [F.]
Populus euphratica was successfully propagated from cuttings without special treatment. Some information on pests and on the areas under various poplars is given.

———— 1959. INFORMES SOBRE LAS ACTIVIDADES DE LAS COMISIONES NACIONALES DEL CHOPO, PERIODO: 1958. ARGENTINA. [REPORTS OF THE ACTIVITIES OF THE INTERNATIONAL POPLAR COMMISSIONS FOR THE PERIOD 1958. ARGENTINA.] [Docum.] 10th Sess. Int. Poplar Comm. No. FAO/CIP/95-L, 5 pp. [Span.]

Jobling, J. 1957. REPORTS OF THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS. UNITED KINGDOM. [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-D, 10 pp. [E.]
A summary of the work of the last 10 years.

———— and Peace, T. R. 1956. PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS FOR THE YEAR 1955: UNITED KINGDOM. [Pap.] Int. Poplar Comm. No. FAO/CIP/82-E, 9 pp.
With an appendix on the growing of willows for timber in the United Kingdom.

Johnsson, H. 1956. PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS: SWEDEN. [Pap.] Int. Poplar Comm. No. FAO/CIP/82-G, 1 pp. [E.]

———— 1957. REPORTS OF THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS. SWEDEN. [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-E, 7 pp. 9 refs. [E.]
Covering research and breeding over the last 10 years.

Kittani, H. 1957. REPORTS OF THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS. IRAQ. [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/186-L, 7 pp. 5 refs. [E.]
Contains data on plantings and outturn of pulpwood and fuelwood, pests and diseases, and native or introduced species and varieties, including a description of P. euphratica.

Marion, J. 1958. UN EXAMPLE SPECTACULAIRE DE DEVELOPPEMENT REGIONAL DES RESOURCES ENBOIS: LA POLITIQUE DE PRODUCTION LIGNEUSE DE LA SOCIETE CARTIERE BURGO DANS LA VALLEE DU PO. [A SPECTACULAR EXAMPLE OF REGIONAL DEVELOPMENT OF TIMBER RESOURCES: THE WOOD-PRODUCTION POLICY OF THE CARTIERE BURGO COMPANY IN THE PO VALLEY.] Le Feuillu Francais de Papeterie, Paris. 20 pp. [F.]
Gives an account of the foundation, by a commercial firm (the Cartiere Burgo), of the Istituto di Pioppicultura at Casale Monferrato for research into poplar cultivation in N. Italy, the results of research to date, and the economics of poplar growing for pulp production.

Muller, R. 1958. DAS WISSENSCHAFTLICHE INSTITUT DES DEUTSCHEN PAPPELVEREINS IN BRUHL BEI KOLN. [THE RESEARCH INSTITUTE OF THE GERMAN POPLAR SOCIETY, BRUHL/COLOGNE.] Forst- u. Holzw. 13(5): 98-9. 4 refs. [G.]
Briefly reviews the Institute's work, particularly on the clear distinction of varieties. In future it will also include comprehensive trial plantings, phenological, morphological, and resistance tests with different varieties, and the breeding of improved varieties.

Sanz-Pastor, M. J. M. 1956. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES POUR L'ANNEE 1955. ESPAGNE. [REPORTS ON THE ACTIVITIES OF THE NATIONAL [POPLAR] COMMISSIONS, 1955. SPAIN.] [Pap.] Int. Poplar Comm. No. FAO/CIP/82-F, 7 pp. 18 refs. [F.]

[Spain: Com. Nac. Chopo] 1957. MEMORIA 1957. [REPORT FOR 1957.] Mem. Com. Nac. Chopo, Madrid 1957. 122 pp. 4 pp. refs. [Span.]
A report in four parts: (1) Work of the Spanish National Poplar Commission in 1957, including 5-year plans of work and research, and a review of the present situation and possibilities for expansion in eight provinces, (2) projected work for 1958, (3) Spanish legislation governing the cultivation and exploitation of poplars, and (4) a list of Spanish publications on poplar up to the time of the report.

———— [1960.] [REPORT OF WORK DURING 1960.] Mem. Com. Nac. Chopo, Madrid. 10 pp. [F.]
Includes reports by this National Commission on progress in breeding, pest and disease control, and pulping experiments with poplar.

———— 1961. [NATIONAL [POPLAR COMMISSION] REPORT ON ACTIVITIES RELATIVE TO THE EXPLOITATION AND UTILIZATION OF POPLARS AND WILLOWS.] Mem. Com. Nac. Chopo, Madrid 1961. 13 pp. [F.]
Deals mainly with poplar and includes reports on exploitation, breeding trials, the occurrence of insect pests, results of strength tests and pulping trials, and weed control in plantations.

Velay, L. 1957. RAPPORTS D'ACTIVITE DES COMMISSIONS NATIONALES. FRANCE. HISTORIQUE ET FONCTIONNEMENT DE LA COMMISSION. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. FRANCE. HISTORY AND FUNCTIONS OF THE COMMISSION.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-B Add. I, 10 pp. 5 refs. [F.]
Covers briefly the organization of research and research projects for the last 10 years.

946.1

Gaillard, E. 1956. LA COMMUNAUTE SUISSE DU PEUPLIER. [THE SWISS POPLAR ASSOCIATION.] Schweiz. Z. Forstw. 107(8/9): 441-3. [F.]
Notes on its membership, aims, and organization.

97 INTERNATIONAL FOREST POLICY AND OTHER INTERNATIONAL COLLABORATION

971 CONGRESSES AND CONFERENCES

Burger, F. W. 1958. INTERNATIONAAL POPULIEREN CONGRES TE PARIJS 16 APRIL TOTIMEI 1957. [INTERNATIONAL POPLAR CONGRESS, PARIS 1957.] Ned. Boschb.-Tijdschr. 30(1): 2-6. [Du.]
Brief reports on the congress as a whole and on the work of the different sections.

Heimburger, C. 1952. THE FOURTH INTERNATIONAL POPLAR CONGRESS IN GREAT BRITAIN AND FOREST TREE BREEDING IN DENMARK. For. Chron. 28(3): 6-23.

Hellinga, G., and Broekhuisen, J. T. M. 1958. VERSLAG VAN DE EXCURSIES GEORGANISEERD IN HET KADER VAN HET ZESDE INTERNATIONALE POPULIERENCONGRES TE PARIJS VAN 16 APRIL TOT 1 MEI 1957. [REPORT ON THE EXCURSIONS ORGANIZED IN THE FRAMEWORK OF THE 6TH INTERNATIONAL POPLAR CONGRESS, PARIS 1957.] Ned. Boschb.-Tijdschr. 30(1): 7-21. [Du.]

Herbignat, A. 1951. QUATRIEME CONGRES INTERNATIONAL DU PEUPLIER: CINQUIEME SESSION ANNUELLE DE LA COMMISSION INTERNATIONALE DU PEUPLIER. [FOURTH INTERNATIONAL POPLAR CONFERENCE: FIFTH ANNUAL SESSION OF THE INTERNATIONAL POPLAR CONFERENCE.] Bull. Soc. For. Belg. 58(12): 497-546. [F.]
Includes short abstracts of some of the papers presented to the Congress.

Houtzagers, G., and Burger, F. W. 1951. HET INTERNATIONALE POPULIEREN CONGRES IN ENGELAND. [THE INTERNATIONAL POPLAR CONGRESS IN ENGLAND.] Ned. Boschb.-Tijdschr. 23(7/8): 210-9. [Du.]
Describes some of the less usual varieties and hybrids seen, and discusses the cultivation of the cricket bat willow and the manufacture of cricket bats.

[Hungary: Erdesz. Kutatas.] 1957. NYARFA-KONFERENCIA. [REPORT ON THE POPLAR CONFERENCE.] Erdesz. Kutatas., Budapest 1957(1/2): 3-18. [Hu.]
Held 23-29 Sept. 1956 by arrangement with the Hungarian Academy of Sciences, and attended by delegates from the USSR, Bulgaria, China, E. Germany, Korea, Rumania, and also Austria and Belgium.

[International: FAO] 1952. REPORT OF THE 5TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION AND PROCEEDINGS OF THE 4TH INTERNATIONAL POPLAR CONGRESS. FAO, Rome. 68 pp.

———— 1953. REPORT OF THE 6TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION, 1952. FAO, Rome. 74 pp.

[International: FAO/Int. Poplar Comm.] 1950. REPORT OF THE 4TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION. FAO, Palais des Nations, Geneva. 33 pp.
Contains inter alia proposals on the nomenclature of the section Aigeiros, notes on field trips in France and Switzerland, notes on a poplar timber study in Switzerland, and observations on poplar growing in Iraq, Syria, and the Lebanon.

———— 1953. LA SECONDA SESSIONE DELLA COMMISSION INTERNATIONALE DU PEUPLIER DAL 20 AL 28 APRILE 1948. [THE SECOND SESSION OF THE INTERNATIONAL POPLAR COMMISSION 20-28 APRIL 1948.] Ente Nazionale per la Cellulosa e per la Carta, Rome. 247 pp.

———— 1954. REPORT OF THE NEAR EAST POPLAR CONFERENCE (DAMASCUS, SYRIA 5-9 APRIL 1954). FAO, Rome. No. FAO/CIP/72, 35 pp.
Includes recommendations by the conference on policy, identification and cultivation, logging and utilization, sample forms relating to identification, cultivation and use and to measuring wood samples at time of felling, and a paper. Information gathered on the study tour (J. Pourtet), on poplars and other tree species in Syria and the Lebanon.

———— 1954. REPORT OF THE 7TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION: GERMANY, MAY 1953. FAO, Rome. 85 pp.
Includes reports on poplar identification, cultivation, diseases and pests based on a study tour in Western Germany; also notes on nomenclature—see Guinier, 1954, and Peace, 1954, both listed in Populus sp., 176.1.

———— 1956. REPORT OF THE 8TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION, SPAIN, APRIL-MAY 1955. FAO, Rome. No. FAO/CIP/81, 85 pp.

———— 1957. RAPPORT DE LA CONFERENCE REGIONALE DU PEUPLIER POUR L'AMERIQUE LATINE, BUENOS AIRES, 1957. [REPORT OF THE LATIN AMERICAN POPLAR CONFERENCE, BUENOS AIRES, 1957.] [Docum.] Int. Poplar Comm. No. FAO/CIP/84, 36 pp. 56 refs. [F.]
Contains recommendations on sites, planting techniques, varieties, utilization, etc., and research needs, with annexed papers on fungus diseases (C. Jauch), insect pests (J. A. Pastrana) and identification (A. Ragonese) of poplars and willows in Argentina, the last dealing more particularly with the natural hybrids of Salix humboldtiana and exotic willows (Salix × argentinensis).

Mendes, J. L. 1962. [[REPORT ON] THE 11TH SESSION OF THE INTERNATIONAL POPLAR COMMISSION.] Estud. Inform. Serv. Flor. Aquic. Portugal No. 171-G 2, 25 pp. [Port.]

Peace, T. R. 1956. INTERNATIONAL POPLAR COMMISSION, 12TH SESSION OF THE PERMANENT EXECUTIVE COMMITTEE, BRUSSELS 24-28 JULY, 1956. REPORT BY U.K. DELEGATE. FAO National Committee Secretariat, London. 6 pp. Restricted.

[Spain: Minist. Agric.] 1955. VIII. SESION DE LA COMISION INTERNACIONAL DEL CHOPO EN ESPANA. [EIGHTH SESSION OF THE INTERNATIONAL POPLAR COMMISSION IN SPAIN.] Ministerio de Agricultura, Patrimonio Forestal de Estado, Madrid. 460 pp. [Span.F.E.]

POPULUS: SECTION AIGEIROS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

165.3

Larsen, C. M. 1963. [POPLAR BREEDING WITH SPECIAL REFERENCE TO THE SECTION AIGEIROS.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-2b/9, 8 pp. [F.f.]
General considerations on provenance trials, choice of parents, heterosis, polyploidy, etc.

165.62

Maisenhelder, L. C. 1961. SELECTION OF POPULUS CLONES FOR SOUTHERN BOTTOM LANDS. Proc., 6th Sth. Conf. For. Tree. Impr., pp. 110-5. 13 refs.

168 HISTOLOGY

Chardenon, J., and Taris, B. 1960. RECHERCHES SUR LA REPRISE DE L'ACTIVITE DU CAMBIUM DE CULTIVARS DE POPULUS, CULTIVE IN VITRO. [STUDIES ON THE RESUMPTION OF CAMBIAL GROWTH OF POPULUS CULTIVARS GROWN IN VITRO.] C. R. Acad. Sci., Paris 251(1): 120-1. [F.]
Results (tabulated) of studies on three cultivars of P. × canadensis and one of P. deltoides showed that in favorable conditions the resumption of cambial growth is independent of season. Proliferation was pronounced in May-June and October-November. Some difference between the cultivars was found.

176.1

Bugala, W. 1956. TOPOLE POLNOCNO-AMERYKANSKIE SEKCJI AIGEIROS DUBY I ICH WPLYW NA UPRAWE TOPOLI W EUROPIE. [NORTH AMERICAN POPLARS OF THE SECTION AIGEIROS AND THEIR INFLUENCE ON THE CULTIVATION OF POPLARS IN EUROPE.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 11: 225-61. 30 refs. [Pol.russ.e.]

181.8

Broekhuizen, J. T. M. 1962. [THE GROWTH RHYTHM OF POPLARS.] Ned. Boschb.-Tijdschr. 34(10): 368-75. 8 refs. [Du.du.e.]

Tucovic, A. 1956. VAZNOST POZNAVANJA FENOLOGIJE CRNIH TOPOLA U NASOJ ZEMLJI ZA NJIHOVO DETERMINISANJE. [THE PHENOLOGY OF BLACK POPLARS IN YUGOSLAVIA AS A GUIDE TO IDENTIFICATION.] Sumarstvo 9(4/5): 251-7. 6 refs. [Croat.e.g.] [Cf. Tucovic, 1954, P. lasiocarpa to P. nigra and vars., 181.8.]
Gives a key based on sex and flushing date (in Belgrade and its environs), supplemented by some other characters. Includes P. nigra var. pyramidalis, P. deltoides, × P. robusta, × P. marilandica, P. virginiana, × P. brabantica, × P. regenerata, × P. gelrica, and × P. serotina.

2 SILVICULTURE

232.32

Peres, A. de Brito. 1962. [BEHAVIOR OF SOME HYBRID POPLARS IN THE MEALHADA FOREST NURSERY.] Estud. Inform. Serv. Flor. Aquic. Portugal No. 172-A 3, 23 pp. [Port.]
Presents information on the nursery soils and methods and costs of raising plants, and gives figures for height and diameter growth of eight cultivars of Populus × 'canadensis' and of P. deltoides cv. "Missouriensis."

Pourtet, J. 1963. QUELQUES REGLES POUR LA CULTURE DES PEUPLIERS NOIRS EN PEPINIERE ET LEUR MISE EN PLACO. [SOME RULES

FOR THE RAISING OF BLACK POPLARS IN THE NURSERY AND THEIR PLANTING OUT.] Rev. For. Franc. 1953(3): 352-9. [F.]

232.328.5

Braun, H. J. 1962. [SUITABLE GRAFTING PERIODS FOR WOODY PLANTS.] Allg. Forst- u. Jagdztg. 133(11): 256-9. 23 refs. [G.g.e.]

263 IRRIGATED FORESTS

Regueral, A. G. 1955. LOS CHOPOS EN LOS NUEVOS REGADIOS DE ESPANA. [POPLARS IN THE NEW IRRIGATION AREAS OF SPAIN.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-K Add. 9, 8 pp. [Span.]

Gives some preliminary information on irrigated plantations of poplar (× Populus regenerata, × P. serotina, P. deltoides var. missouriensis, and P. nigra) established in recent years in various parts of Spain.

271 ARBORETA

Bugala, W. 1956(1957). KOLEKCJA TOPOLI W ARBORETUM KORNICKIM. CZESC II. SEKCJA AIGEIROS DUBY - TOPOLE CZARNE. [THE POPLARS IN KORNIK ARBORETUM. II. SECTION AIGEIROS.] Arbor. Kornickie, Poznan No. 2: 79-113. 53 refs. [Pol.e.russ.]
The collection contains 26 species, varieties, and hybrids.

4 FOREST INJURIES AND PROTECTION

443.3

Stuart, B. E. St. L. 1954. POPLAR CANKER AND FROST. J. Oxf. Univ. For. Soc. (Ser. 4) No. 2: 13-7.

444 VIRUS DISEASES

Berg, T. M. 1962. SOME CHARACTERISTICS OF A VIRUS OCCURRING IN POPLARS. Nature, Lond. 194(4835): 1302-3. 5 refs.

5 FOREST MENSURATION

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Pourtet, J., and Turpin, P. 1954. LE POPULETUM NATIONAL DE VINEUIL (LOIR-ET-CHER). [THE NATIONAL POPULETUM OF VINEUIL (LOIR-ET-CHER).] Rev. For. Franc. 6(1): 9-18. [F.]
Describes the soil, layout, etc., of the arboretum and also gives some figures for increment of various hybrids (P. serotina, P. robusta, P. regenerata) and of P. deltoides.

8 FOREST PRODUCTS AND THEIR UTILIZATION

811.52

Meiden, H. A. van der. 1958. KERNHOUT BIJ POPULIEREN EN ZIJN PRAKTISCHE BETEKENIS. [HEARTWOOD OF POPLARS AND ITS PRACTICAL IMPORTANCE.] Korte Meded. Bosbouwproefsta., Wageningen No. 32, 6 pp. [Du.e.] (Repr. from Houtwereld Oct. and Dec. 1957, and Jan. 1958.)

POPULUS: SECTION TACAMAHACA

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

176.1

Rouleau, E. 1949. LES POPULUS DE LA SECTION TACAMAHACCA EN AMERIQUE. [POPULUS OF THE SECTION TECAMAHACCA IN AMERICA.] Annales de l'ACFAS, Montreal 15: 106. [F.]
The section in America contains three spp. and five varieties. The species hybridize easily with those of the section Aegirus and have produced five hybrids.

Tkacenko, V. I. 1962. [NEW SPECIES OF PLANTS IN THE COLLECTION OF THE FRUNZE BOTANICAL GARDEN.] Bjull. Glavn. Bot. Sada, Moskva No. 45: 55-9. [Russ.latin]

Describes Populus tianschanica and Lonicera sovetkinae spp. nov. (in Russian and Latin), and P.t. var. microphyll var. nov. (in Russian only).

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Joachim, H. F. 1957. BEOBACHTUNGEN UND UNTERSUCHUNGEN AN BALSAMPAPPELN. [OBSERVATIONS AND INVESTIGATIONS ON BALSAM POPLARS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 27 (Beitr. Pappelforsch. No. 2): 35-73. 77 refs. [G.g.]

2 SILVICULTURE

232.11

Bugala, W. 1957(1958). POLNOCNOAMERYKANSKIE TOPOLE SEKCJI TACAMAHACA SPACH I ICH UPRAWA W EUROPIE. [N. AMERICAN POPLARS OF THE TACAMAHACA SECTION IN EUROPE.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 12: 359-81. 15 refs. [Pol.russ.e.]

271 ARBORETA

Bugala, W. 1959. KOLEKCJA TOPOLI W ARBORETUM KORNICKIM. CZESC III. [THE POPLAR COLLECTION AT THE KORNIK ARBORETUM. III.] Arbor. Kornickie, Poznan No. 4: 123-63. 26 refs. [Pol. russ.e.e.]
The collection contains 12 species and 12 hybrids in Section Tacamahaca, and 3 species in Section Leucoides. All are described with notes on performance.

4 FOREST INJURIES AND PROTECTION

416.1

Dance, B. W. 1961. LEAF AND SHOOT BLIGHT OF POPLARS (SECTION TACAMAHACA SPACH) CAUSED BY VENTURIA POPULINA (VUILL.) FABRIC. Canad. J. Bot. 39: 875-90. 25 refs. (Contr. For. Biol. Div. Dep. For. Can. No. 706.)

8 FOREST PRODUCTS AND THEIR UTILIZATION

892.52

Dull, G. G. 1957. THE INVESTIGATION OF CERTAIN ANTIBACTERIALS IN POPULUS TACAMAHACA MILL. AND HYPERICUM PROLIFICUM. Abstr. of thesis, in Dissert. Abstr. 17(7): 1453.
Two sesquiterpene alcohols isolated from the buds of P. tacamahaca showed activity in vitro against Mycobacterium tuberculosis.

POPULUS: SECTION LEUCE

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

164.6

Bartkowiak, S. 1957/1958. PRZYSADKI KWIATOWE U TOPOLI SEKCJI LEUCE DUBY. [BRACTEOLES IN POPLARS OF THE SECTION LEUCE.] Arbor. Kornickie, Poznan No. 3: 221-36. 8 refs. [Pol.e.russ.]
Describes, with illustrations, the differences in the shape of bracteoles of male and female flowers of Populus alba, P. tremula, P. canescens, and P. tremuloides.

———— 1961. BIOMETRYCZNA CHARAKTERYSTYKA PRZYSADEK KWIATOWYCH TOPOL Z SEKCJI LEUCE DUBY. [BIOMETRIC INVESTIGATION OF BRACTEOLES OF POPLARS OF SECTION LEUCE.] Arbor. Kornickie, Poznan 6: 117-30. 4 refs. [Pol.russ.e.e.]
Presents, in tables and graphs, the results of biometric studies on floral bracteoles of poplars in section Leuce.

164.9

Larsen, C. M. 1954. ETUDE RELATIVE AUX VARIATIONS DE LA GRANDEUR DES STOMATES DANS LE GENRE POPULUS. [VARIATIONS IN THE SIZE OF STOMATA IN THE GENUS POPULUS.] [Pap.] 8th Int. Bot. Congr. Paris, Sect. 13: 26-7. [F.]

165.3

[Canada: Ont. Dep. Lds. For.] [1957?] ASPEN POPLARS. Rep. Ont. Dep. Lds. For. 1956/1957, Sect. No. 10(6).

165.41

Bouvarel, P., and Lemoine, M. 1959. HYBRIDATION DES TREMBLES ET PEUPLIERS BLANCS A LA STATION DE RECHERCHES DE NANCY. [HYBRIDIZATION OF ASPENS AND WHITE POPLARS AT THE RESEARCH STATION AT NANCY.] Rev. For. Franc. 11(10): 679-98. 8 refs. [F.]

Grehn, J. 1952. DAS SAMENGEWICHT BEI KREUZUNGEN INNERHALB DER SEKTION POPULUS LEUCE ALS FUNKTION DES WEIBLICHEN UND MANNLICHEN PARTNERS. [SEED WEIGHT IN CROSSES WITHIN POPULUS SECTION LEUCE AS A FUNCTION OF THE MALE AND FEMALE PARENTS.] Z. Forstgenet. 2(1): 8-16. Numerous refs. [G.g.e.]

———— 1952. UBER SPALTUNGSERSCHEINUNGEN UND PHOTOPERIODISCHE EINFLUSSE BEI KREUZUNGEN INNERHALB DER SEKTION POPULUS LEUCE DUBY. [SEGREGATION AND PHOTOPERIODIC INFLUENCES IN CROSSES WITHIN THE POPULUS SECTION LEUCE.] Z. Forstgenet. 1(3): 61-9. 20 refs. [G.g.]

———— 1953. SAMENENTWICKLUNG UND JUGENDWACHSTUM BEI KREUZUNGEN IN DER SEKTION POPULUS LEUCE. [SEED DEVELOPMENT AND SEEDLING GROWTH OF CROSSES WITHIN POPULUS SECTION LEUCE.] Proc., Congr. Int. Union For. Res. Organ., Rome 1953 [Pre-issue], Section 22 (No. 3), 7 pp. 6 refs. [G.g.]

Janson, L. 1960. PROBA ANALIZY STATYSTYCZNEJ CECH MORFOLOGICZNYCH U MIESZANCOWEGO POTOMSTWA TOPOLI PRZY ZASTOSOWANIU METODY WANKEGO. [STATISTICAL ANALYSIS OF THE MORPHOLOGICAL CHARACTERS OF POPLAR HYBRID PROGENY BY WANKE'S METHOD.] Prace Inst. Bad. Lesn. No. 195: 3-29. 2 refs. [Pol. russ.e.]

Schonbach, H. 1957. DIE BISHERIGEN ERGEBNISSE DER ZUCHTUNGSARBEITEN MIT VERSCHIEDENEN PAPPELARTEN DER SEKTION LEUCE. [BREEDING TRIALS WITH POPLARS OF THE SECTION LEUCE. RESULTS TO DATE.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 27 (Beitr. Pappelforsch. No. 2): 149-78. 22 refs. [G.g.]

Seitz, F. W. 1963. [BREEDING OF POPLARS OF THE SECTION LEUCE.] Holz-Zbl. 89(41): 623-4. 7 refs. [G.]
Briefly discusses published results, along with some not yet published in detail, of extensive crossing and selection at Schmalenbeck, referring to a very promising P. tremula × P. tremuloides hybrid which showed excellent height growth in N. and S. Germany, triploid progeny of a grey poplar [cf. Seitz, 1954, P. alba to P. bachofeni, 165.41], etc.

Vloten, H. van. 1954. JEUGDGROEI VAN NAKOMELINGSCHAPPEN UIT KRUISINGEN MET LEUCE-POPULIEREN, EEN GENERATIEVE TOETSING VAN DAARBIJ GEBRUIKTE OUDERS. [JUVENILE DEVELOPMENT OF PROGENIES FROM CROSSES BETWEEN POPLARS OF THE SECTION LEUCE, A BREEDING TEST OF THE PARENT TREES.] T.N.O.-Nieuws, 's Gravenhage No. 99: 195-200. (Reprinted as Korte Meded. Bosbouwproefsta. T.N.O., Wageningen No. 22. 1954. 6 pp.) 2 refs. [Du.e.]

176.1

Frohlich, H. J., and Baumeister, G. 1963. [METHODS OF IDENTIFYING POPLARS OF THE SECTION LEUCE.] Forstarchiv 34(10): 245-52. 4 refs. [G.g.]
From study of many clones of Populus alba, P. × canescens and P. tremula presents descriptions and identification keys based on morphological, color, and physiological characteristics. The method is similar to that for black-poplar identification [see Muller and Sauer, 1958, P. canadensis to P. davidiana, 176.1], but takes additional leaf and petiole characteristics into account.

[Germany: Forst- u. Holzw.] 1962. SONDERHEFT PAPPEL. [SPECIAL NUMBER: POPLARS.] Forst- u. Holzw. 17(12): 225-44. 28 refs. [G.]

Kobendza, R. 1952. TOPOLE SEKCJI LEUCE DUBY W POLSCE. [POPLARS OF THE SECTION LEUCE IN POLAND.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 8: 32-98. 2 refs. [Pol.russ.e.]

Marcet, E. 1961. TAXONOMISCHE UNTERSUCHUNGEN IN DER SEKTION LEUCE DUBY DER GATTUNG POPULUS L. [TAXONOMIC INVESTIGATIONS OF THE SECTION LEUCE OF THE GENUS POPULUS.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 37(4): 269-321. 53 refs. [G.g.f.it.e.]

181.32

Wilde, S. A., and Paul, B. H. 1951. RATE OF GROWTH AND COMPOSITION OF WOOD OF QUAKING AND LARGETOOTH ASPEN IN RELATION TO SOIL FERTILITY. Trans., Wisc. Acad. Sci., Arts & Letters, Madison 40(2): 245-50. 7 refs.

181.521

Larsen, C. M. 1953. FORMATION SPONTANCO DE FLEURS SUR DE JEUNES TREMBLES. [SPONTANEOUS FLOWERING OF YOUNG ASPENS.] Bull. Soc. For. Belg. 60(10): 448-58. 3 refs. [F.]

Lester, D. T. 1961. OBSERVATIONS ON FLOWERING IN THE ASPENS. Proc., 8th Northeast. For. Tree Impr. Conf., New Haven, Conn. 1960: 35-8.

181.8

Schlatzer, G. 1963. SOME OBSERVATIONS ON FOLIATION PHENOMENA IN ASPENS. Arsskr. Vet.-Landbohojsk. 1963: 119-30. 11 refs. [E.e.]
Observations in 1959-62 on irregular foliation patterns, in which the bursting of one or more buds of a single shoot is delayed or accelerated compared with that of the immediate neighbors, on one or more shoots of Populus tremula, P. tremuloides and their hybrids, suggest that the irregularities may be connected with insufficiently low temperatures during dormancy.

2 SILVICULTURE

232.1

Martinez Mata, M. 1959. SECCION DE GENETICA FORESTAL. NOTA SOBRE LA SECCION LEUCE. [SECTION FOR FOREST GENETICS. NOTE ON [POPLARS OF] THE SECTION LEUCE.] An. Inst. For. Invest. Exp., Madrid 31(4): 21-4. [Span.]
Comments are presented on the suitability of Populus tremula, P. tremuloides, P. grandidentata, P. alba, P. alba var. bolleana, and P. × canescens for cultivation in Spain. Particular reference is made to P. × canescens, its origin, characteristics, and suitability for Spain.

232.12/13

Church, T. W., Jr. 1963. SURVIVAL AND GROWTH OF 12-YEAR HYBRID ASPEN COMPARED TO NATIVE WISCONSIN STOCK. U. S. For. Serv. Lake St. For. Exp. Sta. Res. Note No. LS-22, 2 pp. 2 refs.

Pauley, S. S. 1963. PERFORMANCE OF SOME ASPEN SEED SOURCES AND HYBRIDS IN EASTERN MASSACHUSETTS. [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-2b/2, 17 pp. 17 refs.

———— Johnson, A. G., and Santamour, F. S., Jr. 1963. RESULTS OF ASPEN SCREENING TESTS. I, II, III, IV. Minn. For. Notes Nos. 136-139. Each 2 pp. 5 refs.

232.3

Benea, V. 1961. PRODUCEREA DIN SEMINTE A PUIETILOR DE POPULUS ALBA L., × POPULUS CANESCENS SMITH. SI POPULUS TREMULA L. [RAISING P. ALBA, × P. CANESCENS, AND P. TREMULA FROM SEED.] Rev. Padurilor 76(8): 455-9. 27 refs. [Rum.russ.g.f.e.]
Notes on harvesting, storage, treatment, and sowing of seed, and protection of the seedlings.

232.312

Spalek, V. 1950. JAK PESTOVAT TOPOLY ZE SEMEN. [HOW TO RAISE POPLARS FROM SEED.] Sborn. Csl. Akad. Zemed. 22(3/5): 523-32. 3 refs. [Cz.russ.e.]

232.323.2

Marjai, Z. 1960. A MYAR-MAGCSEMETE NOVEKEDESE, FEJLODESE ES KIVALASZTODASA. [GROWTH AND NATURAL SELECTION OF POPLAR SEEDLINGS OF THE SECTION LEUCE.] Erdesz. Kutatas., Budapest 56(1/3): 233-53. 14 refs. [Hu.hu.russ.g.e.]

232.328

Pesina, K. 1962. [VEGETATIVE PROPAGATION OF POPLARS OF SECTION LEUCE BY WINTER CUTTINGS AND BY LAYERS.] Lesnictvi, Praha 8(12): 957-74. 27 refs. [Cz.cz.russ.e.f.]
Describes trials with stem cuttings, root cuttings, and layers, of eight different species, varieties, and hybrids.

Suszka, B. 1958. WEGETATYWNE ROZMNAZANIE TOPOLI Z SEKCJI LEUCE DUBY. [VEGETATIVE PROPAGATION OF POPULUS SECTION LEUCE.] Sylwan 102(3): 66-77. 22 refs. [Pol.]
A review of literature, mostly German.

232.328.1/2

Janson, L. 1962. [A NEW METHOD OF PROPAGATING POPLARS OF SECTION LEUCE.] Sylwan 106(5): 19-27. 10 refs. [Pol.russ.e.]
The method is to take root cuttings 2-6 mm. thick and 5 cm. long, which will root and produce shoots in the same year; these shoots can then be taken as stem cuttings to form extra stock, without impairing the original root cuttings. By leaving a part of each root cutting above the soil, they remained healthier and could assimilate.

232.328.1/3

Kuchlenz, F. 1958. UNTERSUCHUNGEN UBER DIE GUNSTIGSTE WURZELSTECKLINGSLANGE UND -STARKE BEI DER VEGETATIVEN VERMEHRUNG VON PAPPELN DER SECTION LEUCE DURCH WURZELSTECKLINGE. [STUDY ON THE OPTIMUM LENGTH AND THICKNESS OF ROOT CUTTINGS IN VEGETATIVE PROPAGATION OF POPLARS OF THE SECTION LEUCE.] Zuchter 28(7): 336-43. 6 refs. [G.g.]

Suzka, B. 1959. MNOZENIE TOPOLI Z SEKCJI LEUCE DUBY Z SADZONEK ZIELNYCH UZYSKANYCH PRZEZ PODPEDZANIE KORZENI. [PROPAGATION OF POPULUS SECTION LEUCE BY SHOOTS FROM FORCED ROOT CUTTINGS.] Sylwan 103(9): 45-57. 8 refs. [Pol.russ.e.]

232.329.6

Vaage, T., and Borresen, E. 1962. INTERIM REPORT ON TESTS WITH JIFFY-POTS IN FORESTRY. Experimental Research, Jeffy-Pot Ltd., Bergen No. 47, 9 pp. 8 refs. [E.]

271 ARBORETA

Bugala, W. 1955. KOLEKCJA TOPOLI W ARBORETUM KORNICKIM. [THE POPLAR COLLECTION AT THE KORNIK ARBORETUM.] Arbor. Kornickie, Poznan No. 1: 43-59. 53 refs. [Pol.russ.e.]
A general outline, with description of 15 species, varieties, and hybrids in the Section Leuce.

———— 1959. KOLEKCJA TOPOLI W ARBORETUM KORNICKIM. CZESC III. [THE POPLAR COLLECTION AT THE KORNIK ARBORETUM. III.] Arbor. Kornickie, Poznan No. 4: 123-63. 26 refs. [Pol. russ.e.e.]
The collection contains 12 species and 12 hybrids in Section Tacamahaca, and 3 species in Section Leucoides. All are described with notes on performance.

4 FOREST INJURIES AND PROTECTION

443.3

Persson-Huppel, A. 1963. ENZYMATIC SPLITTING OF SUCROSE BY SOME STRAINS OF VALSA NIVEA FR. Stud. For. Suec. Skogshogsk, Stockh. No. 7, 29 pp. 34 refs. [E.e.sw.]
Bark extracts of Populus tremula, P. tremuloides and the hybrid varied in contents of sugars, sucrose being absent from the parents. Strains of V. nivea varied considerably in their ability to decompose the sucrose molecule enzymatically and to use the sugar. The relationship between this and pathogenicity is discussed.

8 FOREST PRODUCTS AND THEIR UTILIZATION

811.79

Haas, B. R., and Kremers, R. E. 1961. ANALYSIS OF STONE CELLS FROM BIGTOOTH AND QUAKING ASPENS. Tappi 44(10): 747-8. 8 refs. *Chemical analysis showed that the stone cells of Populus grandidentata and P. tremuloides barks are similar to the wood of these species, and since they were relatively free from the resins, tannins, proteins, and other plant constituents that make the study of bark lignins difficult, they appear to be good starting materials for further studies. [From the authors' summary.]*

P. ALBA TO P. BACHOFENI

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

160.29

Kazarjan, V. O., and Avundzjan, E. S. 1956. FERMENTATIVNAJA AKTIVNOSTJ LISTJEV RAZNOVOZRASTNYH DEREVJEV I EE IZMENENIE PRI VEGETATIVNOM RAZMNOZENII RASTENII. [LEAF ENZYME ACTIVITY IN TREES OF DIFFERENT AGES, AND CHANGE IN SUCH ACTIVITY AFTER VEGETATIVE PROPAGATION.] Dokl. Akad. Nauk SSSR 108(5): 958-61. 15 refs. [Russ.]

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

Bugala, W. 1951. KILKA NOWYCH ODMIAN I MIESZANCOW POPULUS ALBA L. [SOME NEW VARIETIES AND HYBRIDS OF P. ALBA.] Acta Soc. Bot. Polon. 22(1/2): 43-57. 5 refs. [Pol.e.] *Describes, with illustrations, examples of P. alba var. angustifolia, P. alba var. macrophylla, × P. canescens var. pyramidalis, and × P. rogalinensis (probably a hybrid P. tremula × alba) from the Arboretum at Kornik.*

165.3

Johnson, L. P. V. 1946. A NOTE ON INHERITANCE IN F_1 AND F_2 HYBRIDS OF POPULUS ALBA L. × P. GRANDIDENTATA MICHX. Canad. J. Res. 24th(6): 313-7. Bblg.

165.41

Elorrieta, J. 1957. INFORMES SOBRE LAS ACTIVIDADES DE LAS COMISIONES NACIONALES. ESPANA. INVESTIGACIONES SOBRE LOS CHOPOS CULTIVADOS EN ESPANA. [PROGRESS REPORTS OF NATIONAL [POPLAR] COMMISSIONS. SPAIN. RESEARCH ON POPLARS CULTIVATED IN SPAIN.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-F Add. 2, 2 pp. [Span.] *Includes a report on heterosis observed in Populus tremula × P. alba and P. tremula × P. alba var. bolleana hybrids, in contrast to the experience of W. Wettstein and C. Heimburger, who obtained poor results with the first combination.*

Jablokov, A. S. 1956. PIRAMIDAL NYE TOPOLI. [FASTIGIATE POPLARS.] Goslesbumizdat, Moscow & Leningrad. 58 pp. [Russ.] *Discusses the importance of fastigiate poplars for green-belt and street and roadside planting in the U.S.S.R.; their distribution in cultivation; trials in the breeding of quick-growing, frost-hardy varieties; and propagation.*

Schlenker, G. 1953. BEOBACHTUNGEN UBER DIE GESCHLECHTSVERHALTNISSE BEI JUNGEN GRAUPAPPELN UND ASPEN. [SEX DISTRIBUTION IN YOUNG WHITE POPLAR AND ASPEN.] Z. Forstgenet. 2(5): 102-4. 3 refs. [G.e.]

Schonbach, H. 1960. EINIGE ERGEBNISSE ACHTJAHRIGER ZUCHTUNGSVERSUCHE MIT PAPPELARTEN DER SEKTION LEUCE. [SOME RESULTS OF EIGHT-YEAR-OLD BREEDING TRIALS WITH POPLAR VARIETIES OF THE SECTION LEUCE.] Wiss. Abh. Dtsch. Akad. Landw-Wiss., Berlin No. 44 (Beitr. Pappelforsch. Nc. 4): 7-21. 3 refs. [G.g.russ.e.] [Cf. Schonbach, 1957, Section Leuce, 165.41.]

———— 1962. ERGIBT DIE KREUZUNG POPULUS TREMULA × POPULUS ALBA (UND REZIPROK) LUXURIERENDE BASTARDE? (EIN BEITRAG ZUM HETEROSISPROBLEM BEI WALDBAUMEN). [DO CROSSES OF P. TREMULA AND P. ALBA AND RECIPROCAL CROSSES PRODUCE HYBRID VIGOR? (A CONTRIBUTION TO THE PROBLEM OF HETEROSIS IN FOREST TREES.).] Silvae Genet. 11(1): 3-11. 26 refs. [G.g.e.f.]

Seitz, F. W. 1954. UBER DEN SELBSTUNGS - UND KREUZUNGSERFOLG BEI VERWENDUNG DES POLLENS DER ZWITTRIGEN GRAUPAPPEL VON DILLINGEN. [RESULTS OF SELFING AND CROSSING USING POLLEN OF THE DILLINGEN ANDROGYNOUS GREY POPLAR.] Abstr. in Z. Forstgenet. 3(6): 141. [G.]

———— 1954. UBER DAS AUFTRETEN VON TRIPLOIDEN NACH DER SELBSTUNG ANOMALER ZWITTERBLUTEN EINER GRAUPAPPELFORM. [THE OCCURRENCE OF TRIPLOIDS AFTER SELF-POLLINATION OF ANOMALOUS ANDROGYNOUS FLOWERS OF A GREY POPLAR.] Z. Forstgenet. 3(1): 1-6. 13 refs. [G.g.e.]

Wettstein-Westersheim, W., and Minelli, H. 1962. DIE ZUCHTUNG VON INTERSEKTIONELLEN PAPPELKREUZUNGEN. [BREEDING INTER-SECTIONAL POPLAR HYBRIDS.] Allg. Forstztg. 73(11/12), Suppl. (Informationsdienst No. 57). 2 pp. [G.]

Zurbin, A. I. 1951. POVYSENIE SKRESCIVAEMOSTI VIDOV TOPOLEI PRI POMOSCI PREDVARITELJNOGO VEGETATIVNOGO SBLIZENIJA. [INCREASING THE CAPACITY OF POPLAR SPECIES FOR HYBRIDIZATION BY PREVIOUS GRAFTING [OF ONE PARENT UPON A STOCK OF THE OTHER].] Priroda, Moskva 40(4): 66. [Russ.]

165.42

Kopecky, F. 1960. EXPERIMENTELLE ERZEUGUNG VON HAPLOIDEN WEISSPAPPELN (POPULUS ALBA L.). [EXPERIMENTAL PRODUCTION OF HAPLOID WHITE POPLARS.] Silvae Genet. 9(4): 102-5. 27 refs. [G.g.e.f.]

———— 1960. HAPLOID POPULUS ALBA L. KISERLETI ELOALLITASA. [EXPERIMENTAL PRODUCTION OF HAPLOIDS IN POPULUS ALBA.] Erdesz. Kutatas., Budapest 56(1/3): 151-8. 26 refs. [Hu.hu.russ.g.e.]

165.5

Anonymous. 1932. DIFFERENT GROWTH HABITS OF MALE AND FEMALE P. ALBA. Mitt. Dtsch. Dendrol. Ges. 44: 384.

Vojtus, M. 1961. O NIEKTORYCH TYPOCH BIELYCH TOPOL'OV (POPULUS ALBA L. A POPULUS CANESCENS SM.) V PODUNAJSKYCH LUZNYCH LESOCH CSSR. [SOME TYPES OF WHITE POPLARS (P. ALBA AND P. CANESCENS) IN THE DANUBE FLOOD-PLAIN FORESTS OF CZECHOSLOVAKIA.] Lesn. Cas. 7(3): 161-74. 8 refs. [Slovak.russ.g.]

165.71

Catalan, G. 1963. [CROSSES WITHIN THE SECTION LEUCE AND A NOTABLE HYBRID BETWEEN LEUCE AND AIGEIROS.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63-2b/8, 3 pp. [Span.span.]

Einspahr, D. W. 1962. EUROPEAN WHITE POPLAR-BIGTOOTH ASPEN HYBRID IN WISCONSIN. J. For. 60(5): 345. 3 refs.
Describes a natural hybrid developed under fairly open conditions on a moist sandy site. Height at 17 years was 70 ft., d.b.h. 13.7 in., sp. gr. 0.389, fibre length 0.96 mm., chromosome number 38. The tree is bisexual. Sprouts propagated from this tree are being studied.

Little, E. L., Jr., Brinkman, K. A., and McComb, A. L. 1957. TWO NATURAL IOWA HYBRID POPLARS. For. Sci. 3(3): 253-62. 16 refs.

McComb, A. L., and Hansen, N. J. 1954. A NATURALLY OCCURRING ASPEN-POPLAR HYBRID. J. For. 52(7): 528-9.
Cites map references in Iowa for two stands of Populus grandidentata × alba of good form, rapid growth and apparent disease resistance, for one of which a stand and stock table is given (800 trees and 3,500 cu.ft./acre, 3-9 in. diam., 34-74 ft. with m.a.i. of 145 cu. ft. at 24 yrs., 3-1/2 times as fast as oak of same age.

165.72

Saatcioglu, F. 1956. BOZKAVAK (POPULUS CANESCENS SMITH) MELEZINIM SUN'I CAPRAZLAMA METODIYLE ELDE EDILMESI. [ARTIFICIAL PRODUCTION OF POPULUS CANESCENS BY CROSSING.] Istanbul Univ. Orm. Fak. Derg. 6(2): 70-91. 13 refs. [Turk.g.g.]
Gives details of the laboratory hybridization and culture of P. alba × P. tremula and P. tremula × P. alba, the early nursery growth of which was 20% greater than selfed P. alba. Leaves of the two crosses and of pure P. alba are illustrated.

Scepotjev, F. L. 1954. NOVYE GIBRIDNYE FORMY OSINY. [NEW HYBRID FORMS OF ASPEN.] Dokl. Akad. Nauk SSSR 97(1): 161-4. 2 refs. [Russ.]

[Sweden: Foren. Vaxtforadl. Skogstrad] 1955. [RESISTANCE OF POPLAR HYBRIDS TO RUST.] Arsberatt. Foren. Vaxtforadl. Skogstrad 1954: 11. [Sw.]
Among plants at Ekebo where Mercurialis perennis, the alternate host of Melampsora rostrupii, was abundant, P. tremuloides was completely resistant, and P. tremuloides × P. tremula slightly, P. tremuloides × P. davidiana moderately, and P. tremula × P. davidiana very susceptible.

176.1

Anonymous. 1854. A GIANT WHITE POPLAR IN BOHEMIA. Vereinschr. F.-J.u. Naturk 18: 71.

Bugala, W. 1960. KRYTYCZNY PRZEGLAD ODMIAN GEOGRAFICZNYCH I MIESZANCOW POPULUS ALBA L. ORAZ STUDIA NAD TYM GANTUNKIEM W DOLINIE WISLY. [CRITICAL REVIEW OF GEOGRAPHICAL VARIETIES AND HYBRIDS OF P. ALBA, AND STUDIES ON THE SPECIES IN THE VALLEY OF THE VISTULA.] Arbor. Kornickie, Poznan No. 5: 5-138. 92 refs. [Pol.e.russ.e.]

Gambi, G. 1958. IL PIOPPO BIANCO DELLA LUCCHESIA. [THE WHITE POPLARS OF THE LUCCA REGION OF TUSCANY.] Monti e Boschi 9(12): 659-65. [It.f.e.]
Describes the two local varieties [Populus alba vars. nivea and peronea], which are much more resistant to insect damage than the hybrid black poplars, and give a satisfactory yield (mean annual yield ea. 20-25 cu.m./ha.). Mixed stands of this poplar and Alnus glutinosa are recommended.

Jovanovic, B., and Tucovic, A. 1960. TAKSONOMSKA PROUCAVANJA JASIKE (POPULUS TREMULA L.) ODNOSNO T.ZV. BAHOFENOVE TOPOLE NA DELIBLATSKOJ PESCARI. [TAXONOMIC STUDIES ON ASPEN (P. TREMULA) WITH REFERENCE TO THE SO-CALLED BACHOFEN POPLAR ON THE DELIBLATO SANDS.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 1: 5-41. 24 refs. [Serb.serb.g.]

Jozami, J. M. [1954?] EL ALAMO "ARNALDO MUSSOLINI" EN LA ARGENTINA. [POPULUS "A.M." IN ARGENTINA.] Gobierno de Entre Rios, Direccion de Agriculture y Colonizacion, Parana, Ministerio de Obras Publicas, Comercio e Industria, Gobierno de Entre Rios, Parana. 16 pp. 32 refs. [Span.]
Notes on the poplar, its nomenclature, silvicultural characters, cultivation, growth in Argentina, diseases in Argentina, and properties and uses of the wood.

Merendi, A. 1961. IL GATTICE O PIOPPO BIANCO. [POPULUS ALBA.] Ital. Agric. 98(8): 785-92. 2 refs. [It.]
Describes its silvicultural characters, and gives some data on the increment of Italian plantations.

Prosinski, S. 1954. Z BADAN NAD WYODREBNIANIEM MASY CELULOZOWEJ Z DREWNA TOPOLI CZARNEJ I BIALEJ. [INVESTIGATIONS ON THE PULPING OF POPULUS NIGRA AND P. ALBA.] Sylwan 98(3): 229-38. 19 refs. [Pol.pol.]

Von Solemacher-Antweiler. 1936. POPULUS BACHELIERI. Mitt. Dtsch. Dendrol. Ges. 48: 205-7. [G.]

18 PLANT ECOLOGY

Slavnic, Z. 1952. O EKOLOGIJI BAHOFENOVE TOPOLE. [ECOLOGY OF POPULUS BACHOFENI.] Sum. List 76(1/3): 35-42. 5 refs. [Croat. croat.g.]

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Anonymous. 1865. NATURAL HISTORY OF P. ALBA. Monatschr. F. & J. 9: 60-61.

181.1

Crahay. 1901. THE P. ALBA IN BELGIUM. Bull. Soc. For. Belg. 8: 342.

Schroter. 1926. DISTRIBUTION OF P. ALBA. Bot. Abstr. 15: 9907.

181.521

Greguss, P. 1932. THE POLLEN OF P. ALBA. Biol. Abstr. 6: 3183.

Sauer, E. 1954. BEOBACHTUNGEN AN ZWITTRIGEN PAPPELN. [OBSERVATIONS ON ANDROGYNOUS POPLARS.] Z. Forstgenet. 3(5): 89-91. 6 refs. [G.g.e.] [Cf. Seitz, 1954, P. alba to P. bachofeni, 165.41.]
A study of the androgynous flowers of a young Populus tremula at Stuttgart. Mention is also made of the occurrence of androgynous flowers on an adult P. alba (or possibly P. alba × P. canescens) and a young P. candicans.

181.65

Anonymous. 1922. RAPID GROWTH OF WHITE POPLAR. Bull. Soc. For. Belg. 25: 401.

181.69

Enikeev, S. G. 1953. REDKII SLUCAI ESTESTVENNOI PRIVIVKI. [A RARE CASE OF NATURAL GRAFTING.] Priroda, Moskva 42(7): 110. [Russ.]
Of Populus alba var. bolleana and Fraxinus potamophila in Frunze, Kirgiz S.S.R., a branch of the latter having formed a natural graft with the former's trunk some 30-40 years ago. [No sections appear to have been taken.]

181.71

Bogdanov, P. L. 1952. BELYI TOPOLJ-VELIKAN. [A GIANT POPULUS ALBA TREE.] Priroda 41(5): 117. [Russ.]
Illustrated description of a 35-m. high, 4.2-m. d.b.h. white poplar tree, probably 120-140 years old, growing in the valley of the river Khosta, on the Black Sea shore of the Caucasus. The tree seems to have coalesced from three lateral shoots following the destruction of the apical shoot.

182.21

Karpati, I., and Karpati, V. 1958. ELM-ASH-OAK GROVE FORESTS (QUERCETO-ULMETUM HUNGARICUM SOO) TURNING INTO WHITE POPLAR DOMINATED STANDS. Acta Agronomica Academiae Scientiarum Hungaricae, Budapest 8(3/4): 267-83. 66 refs. [E.e.f. russ.]

2 SILVICULTURE

232.1

Anonymous. 1919. WHITE POPLAR AS A SPECIES FOR AFFORESTATION IN FRANCE. Rev. Eaux For. 57: 93.

232.11

Bispe Lariguet, M. 1958. EL CRECIMENTO DE POPULUS EURAMERICANA I-154 EN TIERRA FIRME DE LA PROVINCIA DE BUENOS AIRES, ARGENTINA. [GROWTH OF P. EURAMERICANA I-154 ON TERRA FIRMA IN BUENOS AIRES PROVINCE, ARGENTINA.] Rev. For. Argent. 2(2): 43-4. [Span.]

232.315.2

Fuisz, J. 1957. A FEHERNYARMAG TAROLASA. [STORAGE OF SEED OF POPULUS ALBA.] Erdo 6(1): 37-9. [Hu.]
From abstr. in Hung. Agric. Rev. 6(3): 7. 1957. [E.]

Polya, L. 1961. INJURY BY SOAKING OF POPULUS ALBA SEEDS Nature, Lond. 189(4759): 159-60. 4 refs.
When air-dried seeds stored in closed vessels at +5°C. were soaked for 15, 35, and 60 min. in distilled or tap water, the percent of abnormal seedlings was 40.2, 40.0, and 45.9 vs. 11.8 in controls. The percent of seeds not germinating also rose slightly.

232.32

Dragomir, N., and Duran, V. 1959. CULTURA PLOPULUI ALB (POPULUS ALBA L.) DIN BUTASI SI PRIN REPICAREA PUIETILOR DIN SEMINTISURI IN PEPINIERA. [PROPAGATION OF P. ALBA BY CUTTINGS AND BY WILDING SEEDLINGS TRANSPLANTED IN THE NURSERY.] Rev. Padurilor 74(1): 26-9. [Rum.russ.g.f.e.]

232.323.2

Partos, G. 1955. FEHER- ES SZURKENYAR-CSEMETEK MAGROL NEVELESE. [RAISING WHITE AND GREY POPLAR SEEDLINGS.] Erdesz. Kutatas., Budapest 1955(2): 155-63. [Hu.russ.e.g.]
To allow for culling, 0.5-0.7 g. (1.0-1.5 c.c.) per sq.m. should be sown, to yield 30 seedlings with a collar diameter of 4 mm. Natural suppression of the rest occurs early. If density is ⊦ 70/sq.m., artificial thinning (to 20-25 stems/sq.m.) appears necessary only if particularly strong plants are required; it should be done when dominants are 25-35 cm. high.

232.328

Delevoy, G. 1940(1945). MULTIPLICATION DU PEUPLIER BLANC. [PROPAGATION OF POPULUS ALBA.] Bull. Soc. For. Belg. 47(7/12): 302-8. [F.]

232.328.1

Bindiu, C. 1959. IN LEGATURA CU INMULTIREA PE CALE VEGETATIVA A PLOPULUI ALB (POPULUS ALBA L.). [THE VEGETATIVE PROPAGATION OF P. ALBA.] Rev. Padurilor 74(4): 206-9. [Rum.russ.g.f.e.]

Bokor, R. 1954. ADATOK A FEHER ES SZURKENYAR VEGETATIV SZAPORITASANAK KERDESEHEZ. [CONTRIBUTIONS TO THE PROBLEM OF THE VEGETATIVE PROPAGATION OF POPULUS ALBA AND P. CANESCENS.] Erdesz. Kutatas., Budapest 1954(1): 18-25. [Hu.?]
From abstr. in Hung. Agric. Rev. 3(3): 8. 1954. [E.]

Samsiev, K. 1959. VLIJANIE TEMPERATURY VOZDUHA I VLAZNOSTI POCVY NA OKORENJAEMOST I ROST CERENKOV TOPOLJA BOLLE. [THE INFLUENCE OF AIR TEMPERATURE AND SOIL MOISTURE ON THE ROOTING AND GROWTH OF POPULUS ALBA VAR. PYRAMIDALIS CUTTINGS.] Lesn. Hoz. 12(9): 66-7. [Russ.]
Trials at Tashkent with cuttings 25 cm. long and 1 cm. in diameter, showed that rooting and growth were better at air temperatures of 11-23° C.(glasshouse) or 13-28° (outdoors) than at 10-18° (indoors), and were better in soil kept at 75% of maximum water-holding capacity than in soil kept at 60 or 45%. [Cf. Samsiev, 1959, Populus sp., 232.328.1.]

Sipos, S. 1957. TAPASZTALATOK A FEHERNYAR DUGVANYOZASAVAL. [EXPERIENCE IN PROPAGATING POPULUS ALBA BY CUTTING.] Erdo 6(3): 111-4. [Hu.]
From abstr. in Hung. Agric. Rev. 6(4): 8-9. 1957. [E.] *In April, planted cuttings were exposed to half their length in the soil, which was then rammed and irrigated twice. A week later the cuttings were buried under 2 cm. of soil and after a month, when new shoots were 2-3 cm., uncovered to expose 2-3 buds. In summer, irrigation was done as required. The rooted cuttings were 73% against 50% by normal methods.*

Takagi, T. 1951. [MORPHOLOGICAL POLARITY OF STEM CUTTINGS OF POPLAR.] Sci. Bull., Faculty of Agric., Kyushu Univ. 13(1/4): 248-53. 11 refs. [Jap.jap.e.]
Cuttings of P. alba were treated with different concentrations of potassium alpha-naphthalene acetic acid in lanolin. When treated with 5 and 1 mg./g. concentrations, normal cuttings treated at the apex produced roots at the apex and buds at the base, and inverted cuttings treated at the base produced buds at the apex and roots at the base. This did not occur with concentrations of 0.9 mg. or 20 mg./g., and the latter proved toxic.

232.328.4

Partos, G. 1956. A FENER ES A SZURKENYAR VEGETATIV SZAPORITASA. [THE VEGETATIVE PROPAGATION OF WHITE AND GREY POPLARS.] Erdesz. Kutatas., Budapest 1956(4): 167-73. 4 refs. [Hu.russ.e.g.]

232.328.5

Gambi, G. 1959. PROMETTENTE RISULTATO DELL' INNESTO DEL "POPULUS TREMULA" L. SU "POPULUS ALBA" L. [PROMISING RESULTS FROM THE GRAFTING OF P. TREMULA ON TO P. ALBA.] Monti e Boschi 10(12): 623-7. 3 refs. [It.f.e.]
On March 31, 1959, P. tremula scions were grafted on to 39 one-year rooted cuttings of P. alba. By July 3, 26 of the grafts had taken, with a mean scion shoot length of 1.2 m. Crown grafts were more successful than slit grafts.

Jakovlev, P. K. 1961. [PROPAGATING POPULUS ALBA VAR. PYRAMIDALIS BY GRAFTING.] Bjull. Glavn. Bot. Sada, Moskva No. 43: 87. [Russ.]

232.411.5

Rubbo, R. 1962. [THE ADVANTAGES OF USING "PIOPELLE" AND SEMI-"PIOPELLE" PLANTING STOCK FOR HYBRID ITALIAN POPLARS.] Silvicultura, Uruguay No. 17: 5-14. [Span.span.e.f.]
Presents the 1st-year's results of trials in establishing plantations of Populus × 'A.M.' using different kinds of planting stock.

232.43

Tuset, R. 1962. [GROWTH DATA FROM WIDELY SPACED POPLAR PLANTATIONS.] Silvicultura, Uruguay No. 17: 15-27. [Span.e.f.]

233 AFFORESTATION

Lucke, H. 1956. VERSUCH EINER HEIDEODLANDAUFFORSTUNG MIT PAPPELN. [HEATHLAND AFFORESTATION TRIALS WITH POPLARS.] Holzzucht, Reinbek 10(2): 9-10. [G.]

Radulovic, S. 1958. O BAHOFENOVOJ TOPOLI NA DELIBLATSKOM PESKU I REZULTATIMA DOSADASNJIH PROUCAVANJA. [POPULUS BACHOFENI ON THE DELIBLATO SANDS: RESULTS OF RECENT STUDIES.] Topola, Beograd No. 8: 673-9. 6 refs. [Serb.f.]

234 FORMATION OF FOREST BY NATURAL SUCCESSION

Babos, I. 1955. A NYARFASOK HOMOKBUCKAN ELOFORDULO MEGJELENESI FORMAI. [FORMS OF JUNIPER/POPLAR STANDS GROWING ON SAND HILLS.] Erdesz. Kutatas., Budapest 1955(4): 31-86. 22 refs. [Hu.russ.e.g.]

236.1

Freyenhagen, H. 1955. DER EINFLUSS VON BODENBEARBEITUNG UND DUNGUNG AUF DIE ERTRAGNISSE BEIM FLURHOLZANBAU. [THE EFFECT OF SOIL CULTIVATION AND FERTILIZING ON WOOD YIELDS OUTSIDE THE FOREST.] Holzzucht, Reinbek 9(1): 4-5 [G.]

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Marchesin, L. 1957. LA MADERA DEL ALAMO Y SAUCE EN LA INDUSTRIA DEL FOSFORO. [POPLAR AND WILLOW WOOD IN THE MATCH INDUSTRY.] Forestal, B. Aires No. 3: 9. [Span.]

4 FOREST INJURIES AND PROTECTION

416.17

[U.S.A.: Rocky Mt. For. Range Exp. Sta.] 1961. BROOMING OF NARROWLEAF COTTONWOOD [POPULUS ANGUSTIFOLIA] AND ASPEN [POPULUS TREMULOIDES] MAY RESULT FROM WINTER INJURY. Extr. from Rep. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. 1960: 18.
Superficially the brooms resemble brooms of parasitic origin, but it is suspected that they are regrowths following the killing of the original branches by severe spring frost. Brooms on both species are characterized by unusually large leaves, e.g. 7 in. long on aspen vs. 2-3 in. for normal leaves.

443 SALVAGE AND DISPOSAL OF FIRE-DAMAGED TIMBER

Dupias, G. 1943. CONTRIBUTION A L'ETUDE DES UREDINEES DE LA HAUTE-GARONNE. [CONTRIBUTION TO THE STUDY OF THE UREDINEAE OF THE HAUTE-GARONNE.] Bull. Soc. Hist. Nat. Toulouse 78: 32-52. [F.] Abstr. in Rev. Appl. Mycol. 27(6): 257-8. 1948.
List of rusts of the Haute-Garonne including Melampsora medusae on Populus angulata and Gymnosporangium juniperi on Sorbus domestica.

Servazzi, O. 1938. CONTRIBUTIONS TO THE PATHOLOGY OF POPLARS. V. RECORDS OF CANKERS ON THE WHITE POPLAR. Boll. Lab. Sper. R. Oss. Fitopat, Torino 15(1/2): 30-3. [It.e.] Plant Sci. Lit. 8(9): 7. 1938.

443.3

Dance, B. W. 1957. A FUNGUS ASSOCIATED WITH BLIGHT AND DIEBACK OF HYBRID ASPEN. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 13(6): 1-2.
Throughout Ontario the progeny of Populus alba × P. grandidentata are severely attacked by a blight and dieback (symptoms described), consistently associated with an unidentified species of Gloeosporium. The disease has not been observed on either parent.

Domanski, S. 1954. BADANIA NAD BIOLOGIA FOMES IGNIARIUS (LINN.) FR. NA BIALODRZEWIE (POPULUS ALBA L.). [THE BIOLOGY OF F. IGNIARIUS ATTACKING WHITE POPLAR.] Acta Soc. Bot. Polon. 23(3): 589-616. 28 refs. [Pol.e.]

Pagony, H. 1961. [HEART ROT OF POPULUS ALBA, PHELLINUS (FOMES) IGNIARIUS (L. EX FR.) QUELET.] Erdeszettud. Kozl., Sopron 1961(1): 79-90. 12 refs. [Hu.hu.russ.g.e.]
Extension of a former report (see Domanski, above) with colored illustrations, both macro- and microscopic, of the affected tissues. The material examined was 2 trees of P. alba and 2 of P. canescens.

Pereda, F. C. 1955. HADROMICOSIS DEL ALAMO PRODUCIDA POR VERTICILLIUM ALBO-ATRUM (R.Y B.). [VERTICILLIUM WILT OF POPLARS PRODUCED BY V. ALBO-ATRUM.] Idia No. 96: 22-4. 9 refs. [Span.]

Sarasola, A. A., and Magi, A. O. 1951. ALGUNOS FACTORES AMBIENTALES EN CORRELACION CON LA CANCROSIS DE LOS ALAMOS (MYCOSPHACRELLA POPULORUM THOMP.). [SOME ENVIRONMENTAL FACTORS RELATED TO POPLAR CANKER.] Phyton, B. Aires 1(1): 42-5. 1 ref. [Span.e.]

Sinadskii, Ju. V., and Bondarceva, M. A. 1956. MALOIZVESTNYE TRUTOVIKI NA POPULUS I TAMARIX I IH ZNACENIE V KARA-KALPAKSKOI ASSR. [LITTLE KNOWN SPECIES OF INONOTUS ON POPLARS AND TAMARISK, AND THEIR SIGNIFICANCE IN THE KARA-KALPAK ASSR.] Bot. Z. 41(8): 1177-83. 3 refs. [Russ.]

453 INSECTS

Patocka, J. 1953. HOUSENKY SKODICI TOPOLECH VEL'KEHO ZITNEHO OSTREVA V ROKU 1952. [CATERPILLAR PESTS ON POPLARS ON VEL'KY ZITNY ISLAND [SLOVAKIA] IN 1952.] Pol'ana 9(6): 131-3. [Cz.]

Santoro, F. H. 1957. CONTRIBUCION AL CONOCIMIENTO DE LA BIOLOGIA DE PLATYPUS SULCATUS. [THE BIOLOGY OF P. SULCATUS.] Rev. Invest. For., B. Aires 1(3): 7-20. 11 refs. [Span.]

Tomic, D. 1958. PRILOG POZNAVANJU CIKLUSA RAZVICA MALOG TOPOLINOG STAKLOKRILCA. [THE LIFE-HISTORY OF SCIAPTERON TABANIFORME.] Zast. Bilja No. 49/50: 87-94. 7 refs. [Serb.e.]
Presents data on the life-history of S. tabaniforme damaging white poplar, particularly in the region of Vojvodina. All ages are attacked, but most frequently 2- to 5-year-old trees. Stems, particularly the lower part, suffer more than branches, though heavy attack on branches has been observed in old overdense stands. [From author's summary.]

5 MENSURATION

524.12

Armasescu, S., and Decei, I. 1954. CERCETARI ASUPRA COEFICIENTILOR DE FORMA AI ARBORILOR DE PLOP ALB SI PLOP NEGRU. [FORM FACTORS FOR TREES OF POPULUS ALBA AND P. NIGRA.] Bull. Sti. Acad. Repub. Rom. (Sect. Sti. Biol.) 6(2): 475-90. 6 refs. [Rum.russ.f.russ.f.]
The form factor (tree volume/cylindrical volume) does not vary between the two species, it varies in both with diameter as well as height, and is constant (0.427) for all trees of ≥ 50 cm. d.b.h. These conclusions are drawn from analysis of 404 black and 1,100 white poplars from different parts of Rumania.

Csiszar, I. 1955. FATOMEGTABLAK SZERKESZTESE. [[A STEP TOWARDS THE] CONSTRUCTION OF POPLAR VOLUME TABLES.] Erdesz. Kutatas., Budapest 1955(4): 15-29. 8 refs. [Hu.russ.e.g.]

568 OTHER MENSURATIONAL STUDIES OF STAND CONSTITUTION AND CHANGES THEREIN. DISTRIBUTION OF GROWTH BY TREE CLASSES, ETC.

McComb, A. L., and Hansen, N. J. 1954. A NATURALLY OCCURRING ASPEN-POPLAR HYBRID. J. For. 52(7): 528-9.
Cites map references in Iowa for two stands of Populus alba × P. grandidentata of good form, rapid growth and apparent disease resistance, for one of which a stand and stock table is given (800 trees and 3,500 cu.ft./acre, 3-9 in. diam., 34-74 ft. with m.a.i. of 145 cu. ft. at 24 years, 3½ times that of oak of same age.

8 FOREST PRODUCTS AND THEIR UTILIZATION

811 STRUCTURE. IDENTIFICATION

Walek-Czernecka, A. 1952. ANATOMIA POROWNAWCZA DREWNA POPULUS ALBA L., POPULUS TREMULA L., POPULUS CANESCENS SM. [COMPARATIVE WOOD ANATOMY OF P. ALBA, P. TREMULA, AND P. CANESCENS.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 8: 1-31. 21 refs. [Pol.russ.f.]

811.142/143

Kasarian, W. O. [Kazarjan, V. O.], and Abramian [Abramjan], B. M. 1956. [CHANGES IN THE WATER-CONDUCTING SYSTEMS OF WOODY PLANTS WITH HEIGHT IN THE STEM.] Dokl. Akad. Nauk Armjanskoi SSR 22: 129-34. [Russ?] From abstr. in Holzforschung, Berlin 10(6): 190. 1956. [G.]
Describes an anatomical study of the frequency, distribution, and diameter of vessels in shoots and stems of Salix alba var. pendula and Populus alba.

812 PHYSICAL AND MECHANICAL PROPERTIES

Horvat, I. 1960. PRILOG POZNAVANJU NEKIH FIZICKIH I MEHANICKIH SVOJSTAVA BIJELE I CRNE TOPOLOVINE (POPULUS ALBA L.,

POPULUS NIGRA L.). [SOME PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF P. ALBA AND P. NIGRA.] Sum. List 84(3/4): 95-115. 12 refs. [Croat.croat.e.]

Lenz, O. 1956. LE BOIS DES PRINCIPAUX PEUPLIERS ET D'UN SAULE INDIGENES EN SUISSE. [THE WOOD OF THE CHIEF POPLARS AND OF A WILLOW NATIVE TO SWITZERLAND.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 32(5): 203-27. 12 refs. [F.f.g.it.e.]

812.2/3

Benic, R. 1960. RASPORED NEKIH FIZICKIH SVOJSTAVA DRVETA U DEBLU BELE TOPOLE I BELE VRBE. [THE DISTRIBUTION OF SOME PHYSICAL PROPERTIES OF WOOD IN THE STEM OF POPULUS ALBA AND SALIX ALBA.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 2: 83-123. 12 refs. [Serb.serb.e.e.]
Presents results of studies on variations, either transversely (from periphery to pith) or longitudinally, in ovendry and nominal sp. gr., radial, tangential and volume shrinkage, and fibre-saturation point.

813 WOOD CHEMISTRY

[Spain: Inst. For. Invest. Exp.] 1956. LABORATORIO GENERAL DE QUIMICA FORESTAL. QUIMICA DE LA MADERA. [GENERAL LABORATORY OF FOREST CHEMISTRY. WOOD CHEMISTRY.] An. Inst. For. Invest. Exp., Madrid No. 1: 69-70. [Span.]
Presents results of chemical analyses of wood of Eucalyptus obliqua, Pinus pinaster, and Populus bolleana.

827.1

Lawniczak, M., and Radlinski, A. 1957. BADANIA NAD MOZLIWOSCIA GIECIA DREWNA TOPOLOWEGO. [INVESTIGATIONS ON THE POSSIBILITY OF BENDING POPLAR WOOD.] Przem. Drewny 8(5): 12-4. 3 refs. [Pol.]

832.2

[U.S.A.: For. Prod. Lab.] 1950. VENEER CUTTING AND DRYING PROPERTIES. COTTONWOOL. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. D1766-3, 4 pp. 4 refs.

[U.S.A.: Veneers & Plyw.] 1936. THE MYSTERY OF THE ASPEN. Veneers & Plyw. 30(12): 10.
Deals with the origin and incidence of silver poplar, the veneer from which is known as aspen, on the eastern shores of the United States.

861.0

Prosinski, S. 1954. Z BADAN NAD WYODREBNIANIEM MASY CELULOZOWEJ Z DREWNA TOPOLI CZARNEJ I BIALEJ. [INVESTIGATIONS ON THE PULPING OF POPULUS NIGRA AND P. ALBA.] Sylwan 98(3): 229-38. 19 refs. [Pol.pol.]

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

907.1

Heineck. 1930. PYRAMIDAL P. ALBA AVENUE. Mitt. Dtsch. Dendrol. Ges. 42: 364.

P. BALSAMIFERA TO P. BEROLINENSIS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

160.22

Ibrahim, R. K., and Towers, G. H. N. 1960. THE IDENTIFICATION, BY CHROMATOGRAPHY, OF PLANT PHENOLIC ACIDS. Arch. Biochem. 87(1): 125-8. 9 refs.
A method is described for the separation and identification of 21 phenolic acids. A very brief survey of species [including Populus tacamahaca, Betula dahurica, and Tsuga canadensis] indicates that the distribution of some of these compounds is much more extensive than has been supposed. [From authors' summary.]

161.4

Brown, A. B. 1937. ACTIVITY OF THE VASCULAR CAMBIUM IN RELATION TO WOUNDING IN THE BALSAM POPLAR, P. BALSAMIFERA L. Canad. J. Res. (Bot. Sci.) 15: 7-31. Plant Sci. Lit. 5(7): 4. 1937.

———— 1937. ON HETEROAUXIN AND CAMBIAL ACTIVITY IN POPULUS BALSAMIFERA. Nature 140(3551): 898-99.

165.41

Li, S. -W. 1960. PRIMENENIE MNOGOKRATNOGO OPYLENIJA V SELEKCII TOPOLEJ. [REPEATED POLLINATION IN POPLAR BREEDING.] Vestn. Sel'.-Hoz. Nauki 5(2): 140-3. 5 refs. [Russ.e.g.f.]

Manzos, A. M. 1960. BYSTRORASTUSCAJA FORMA POPULUS BALSAMIFERA L., POLUCENNAJA OT OPYLENIJA ZENSKIH CVETKOV POPULUS BALSAMIFERA L. FRAKCIONIROVANNOJ PYL'COJ ETOGO VIDA. [FAST-GROWING FORM OF P. BALSAMIFERA OBTAINED BY POLLINATING FEMALE FLOWERS WITH FRACTIONATED POLLEN OF THE SAME SPECIES.] Dokl. Akad. Nauk SSSR 131(2): 433-5. 8 refs. [Russ.]

176.1

Joachim, H. F. 1956. UNTERSUCHUNGEN UBER POPULUS BEROLINENSIS DIPPEL. [INVESTIGATIONS OF P. BEROLINENSIS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 16 (Beitr. Pappelforsch. No. 1): 71-101. 22 refs. [G.g.]

Redman, K. 1942. NOMENCLATURE CONFUSION IN THE CASE OF THE BALSAM POPLAR OR TACAMAHAC. J. Amer. Pharm. Ass. (Sci. ed.) 31(7): 220-3. Bblg.

Rouleau, E. 1946. POPULUS BALSAMIFERA OF LINNAEUS NOT A NOMEN AMBIGUUM. Rhodora 48(569): 103-10. Bblg.

———— 1948. TWO NEW NAMES IN POPULUS [:P. BALSAMIFERA L. VAR. FERNALDIANA NOM. NOV. (= P. BALSAMIFERA VAR. MICHAUXII HENRY) AND × P. GILEADENSIS STAT. ET NOM. NOV. (BALSAMIFERA × DELTOIDES VAR. MISSOURIENSIS?; P. CANDICANS SENSU MICHX.)]. Rhodora 50(597): 233-6.

Suringar. 1929. SYSTEMATY OF P. BALSAMIFERA. Mitt. Dtsch. Dendrol. Ges. 41: 29.

Tucovic, A. 1955. PRILOG POZNAVANJU BERLINSKE TOPOLE (× POPULUS BEROLINENSIS DIPPEL). [CONTRIBUTION TO THE KNOWLEDGE OF P. BEROLINENSIS.] Sumarstvo 8(6): 338-44. 11 refs. [Croat.e.g.]
A general description, with some details relating to P. berolinensis in Serbia.

181 MODE OF LIFE, AUTECOLOGY

Roe, E. I. 1958. SILVICAL CHARACTERISTICS OF BALSAM POPLAR (POPULUS BALSAMIFERA). U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 65, 17 pp. 42 refs.

181.311

Krolikowski, L., and Baranski, R. 1961. [EFFECT OF DIFFERENT SOIL MOISTURE CONTENT ON POPLAR GROWTH.] Roczn. Gleboznawcze, Warsz. 10 (Suppl.): 719-21. [Pol.]
P. maximowiczii × P. × berolinensis cuttings grew best at soil m.c. 75%, then 100%, then 50%, and finally 25%.

181.342

Krolikowski, L., and Baranski, R. 1961. [EFFECT OF SOIL ACIDITY ON THE GROWTH OF THE HYBRID POPULUS 277.] Roczn. Gleboznawcze, Warsz. 10 (Suppl.): 714-6. [Pol.]
Cuttings of P. maximowiczii × P. × berolinensis grew best at pH 6-8, less well at pH 4.5 and not at all at pH 3.

181.41

Junas, G. G. 1952. PROJAVLENIE MEZVIDOVOI VZAIMOPOMOSCI V LESNYH POSADKAH NA SUHIH DJUNNYH PESKAH BUZULUKSKOGO BORA. [MUTUAL ASSISTANCE AMONG SPECIES USED FOR THE AFFORESTATION OF THE DUNE SANDS OF THE BUZULUK PINE FOREST.] Lesn. Hoz. 5(2): 56-61. [Russ.]

181.525

Buc, T. G. 1961. [COMPARATIVE STUDY OF THE BIOLOGICAL FEATURES OF SEEDS OF TUSSILAGO FARFARA, POPULUS [BALSAMIFERA] AND SALIX [NIGRICANS].] Bjull. Glavn. Bot. Sada, Moskva No. 41: 66-73. 9 refs. [Russ.]
Compares the dependence of germination on temperature; the change in the content of SH-groups during germination; and the distribution of physiologically active substances and of the activity of respiratory enzymes during germination.

181.63

Korovin, V. A. 1960. "VETKOPAD" U TOPOLJA. ["TWIG SHEDDING" IN POPLARS.] Priroda, Moskva 49(6): 68. [Russ.]

181.8

Marcet, E. 1956. DIE PHANOLOGIE ALS BESTIMMUNGSMERKMAL BEI PAPPELSORTEN. [PHENOLOGY AS A DISTINGUISHING CHARACTER OF POPLAR VARIETIES.] Ber. Schweiz. Bot. Ges., Zurich 66: 5-18. 8 refs. [G.g.]

2 SILVICULTURE

Day, M. W., and Vogel, F. H. 1944. SILVICULTURE AND UTILIZATION OF BALSAM POPLAR. J. For. 42(7): 512-4.

228 CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Godnev, E. D. 1950. O VZAIMOOTNOSHENIYAKH TOPOLYA I BUZINY V LESOPOSADKAKH. [ON THE MUTUAL RELATIONS OF POPLAR AND ELDER IN FOREST PLANTATION.] Agrobiologija 1950(2): 101-4. 2 refs. [Russ.]

232.1

Pourtet, J. 1950. LES PEUPLIERS BAUMIERS ET LEURS HYBRIDES. [THE BALSAM POPLARS AND THEIR HYBRIDS.] Rev. For. Franc. No. 6: 317-22. [F.]
A short account of this section of Populus, and an estimate of their suitability for planting in France.

234 FORMATION OF FOREST BY NATURAL SUCCESSION

Leisman, G. A. 1955. A VEGETATION AND SOIL CHRONOSEQUENCE ON THE MESABI IRON RANGE SPOIL BANKS, MINNESOTA. Abstr. of thesis, in Dissert. Abstr. 15(11): 1987-8. [Univ. Minn.]

———— 1957. A VEGETATION AND SOIL CHRONOSEQUENCE ON THE MESABI IRON RANGE SPOIL BANKS, MINNESOTA. Ecol. Monogr. 27(3): 221-45. 34 refs.

4 FOREST INJURIES AND PROTECTION

443.3

Wallin, W. B. 1954. WETWOOD IN BALSAM POPLAR. Minn. For. Note No. 28, 2 pp.

453 INSECTS

Morris, R. F. 1956. NOTE ON PARANTHRENE TABANIFORMIS ROTT., A MOTH NEW TO NORTH AMERICA (LEPIDOPTERA: AEGERIIDAE). Canad. Ent. 88(11): 652. 4 refs. (Contr. Div. Ent. Dep. Agric. Can. No. 3456.)
Larvae were found at Mount Pearl, Newfoundland, in 1952, boring into the stem of an injured Populus balsamifera—probably the first record of this European species in N. America.

524.315

Young, H. E. 1957. MERCHANTABLE HEIGHT VOLUME TABLES FOR RED AND SUGAR MAPLE, WHITE BIRCH, AND POPLAR. Tech. Note Univ. Me. For. Dep. No. 45, 4 pp.
Volumes to a 4-in. top diameter u.b.

525.1

Georgiev, Z. 1956. OPITNO-SORTIMENTNI TABLICI ZA KANADSKATA TOPOLA. [ASSORTMENT TABLES FOR POPULUS × 'CANADENSIS' [IN BULGARIA].] Gorsko Stopanstvo 12(5): 231-3. [Bulg.]
For ages 5, 10, 15, 20, 25, and 30 years, and site classes 1b, 1a, and 1.

532 QUANTITY AND AREA OF FOLIAGE

Danilov, M. D., and Stepanov, V. S. 1960. LISTOVAJA MASSA I EFFEKTIVNOST' EE DEJATEL'NOSTI V PJATNADCATILETNEM NASAZDENII TOPOLJA BAL'ZAMICESKOGO. [THE LEAF MASS AND ITS EFFICIENCY IN STANDS OF POPULUS BALSAMIFERA 15 YEARS OLD.] Lesn. Z., Arhangel'sk 3(2): 8-12. [Russ.] [Cf. Rodionov, 1959, below.]

Rodionov, M. S. 1956. K METODIKE OPREDELENIJA KOLICESTVA LISTVY V MOLODYH POLEZASCITNYH LESNYH NASAZDENIJAH. [METHODS OF DETERMINING THE AMOUNT OF FOLIAGE IN YOUNG SHELTERBELT STANDS.] Bot. Z. 41(4): 532-4. 8 refs. [Russ.]

———— 1959. OB OPREDELENII MASSY LISTVY ZASCITNYH LESOPOLOS. [DETERMINING FOLIAGE WEIGHT IN SHELTERBELTS.] Bot. Z. 44(3): 333-7. 9 refs. [Russ.]

551 IN SINGLE TREES WITH ANNUAL RINGS

Kirby, C. L. 1953. ACCURACY OF RING COUNTS ON POPLAR. Silv. Leafl. For. Br. Can. No. 85, 2 pp.
Eighty-seven percent of ring counts in the field on 23 representative sample discs of P. tremuloides and P. balsamifera were below those made in the laboratory. This may be attributed to indistinct demarcation between early and late wood and to the presence of decay.

566 YIELD TABLES AND THEIR CONSTRUCTION

Armasescu, S. 1959. TABELE GENERALE DE PRODUCTIE PENTRU PLOPII NEGRI HIBRIZI DIN R.P.R. [GENERAL YIELD TABLES FOR HYBRID BLACK POPLARS IN RUMANIA.] Rev. Padurilor 74(10): 589-92. 11 refs. [Rum.]
Describes the data and construction of the tables, extracts from which are given for 3 out of the 5 yield classes. Some comparative data from Germany, Czechoslovakia, Bulgaria, and Hungary are also given. Tables cover ages 4-26. The poplars most frequently planted in Rumania are Populus × marilandica and P. × regenerata.

Avram, C. 1959. TABELE DE PRODUCTIE PROVIZORII PENTRU PRINCIPALELE SPECII FORESTIERE DIN LUNCA DUNARII. [PROVISIONAL YIELD TABLES FOR THE PRINCIPAL FOREST TREE SPECIES GROWING ON THE BANKS OF THE DANUBE.] Rev. Padurilor 74(3): 156-9. [Rum. russ.g.f.e.]
Gives tables of pollarded willows, osiers, hybrid black poplars, and Fraxinus pennsylvanica.

6 FOREST MANAGEMENT

613 EXPLOITABILITY AND ROTATION

Kallay, J. 1962. [ECONOMICS OF POPLAR GROWING, PARTICULARLY ON SHORT ROTATIONS.] Erdo 11(9): 394-402. [Hu.g.russ.]
Compares data on volume, quality, and financial yields of final fellings in robinia, oak, and poplar. Poplar rotations of 20 years, or possibly even less, are considered economic and it is recommended to plant one or two short generations of poplars after robinia or oak on suitable sites. [From author's summary.]

Toth, B. 1962. [POPLAR STANDS WITH SHORT ROTATIONS.] Erdo 11(9): 385-93. 3 refs. [Hu.g.russ.]
Argues, with some growth and soil data for illustration, that on a number of sites, frequently oak sites, unsuitable for long poplar rotations but whose top 50 cm. of soil can support poplars, pulpwood rotations of 12-15 years would be economic. Populus × 'Robusta' and, for wet sites, P. × 'marilandica' are suggested.

651.5

Schmitz-Lenders, B. 1958. HOHE ODER NIEDRIGE UMTRIEBE BEIM PAPPELANBAU. [LONG OR SHORT ROTATIONS FOR POPLAR PLANTATIONS?] Allg. Forst- u. Jagdztg. 129(7): 163-7. 1 ref. [G.e.]

653 VALUE INCREMENT OF THE STEM; DEVELOPMENT AND STRUCTURE OF THE STAND AS REGARDS VALUE

Gravenstedt. 1960. ERTRAGE AUS ALTEREN PAPPELANPFLANZUNGEN ALS HINWEIS FUR ZUKUNFTIGEN ANBAU. [YIELDS FROM OLD POPLAR PLANTATIONS AS A POINTER FOR FUTURE PLANTING.] Forst- u. Holzw. 15(11): 213-4. [G.]

8 FOREST PRODUCTS AND THEIR UTILIZATION

810 GENERAL INFORMATION ON WOOD

Betts, H. S. 1942. AMERICAN WOODS: BALSAM POPLAR. U. S. For. Serv., 4 pp. Bblg.

811.156

Scaramuzzi, G. 1958(1959). VARIAZIONI DIMENSIONALI DELLE FIBRE NEL FUSTO IN POPULUS × EURAMERICANA CV. 'I 214'. [VARIATION IN THE DIMENSIONS OF FIBRES IN A STEM OF P. × CANADENSIS CV. 'I 214'.] Pubbl. Cent. Sper. Agric. For., Roma 2: 87-118. 34 refs. [It.it.e.e.]

———— 1959(1960). INDAGINI TECNOLOGICHE SUL LEGNO DI ALCUNI IBRIDI EURAMERICANI DI PIOPPO. II. DATI ANATOMIC . [TECHNOLOGICAL INVESTIGATIONS ON THE WOOD OF SOME HYBRID POPLARS [POPULUS × 'CANADENSIS']. II. Anatomical data.] Pubbl. Cent. Sper. Agric. For., Roma No. 3: 193-216. 38 refs. [It.it.e.e.]
The investigations already made on clone 'I 214' have been extended to three other clones ('I 154', 'I 455', and 'I 488 b').

811.22

Messeri, A. 1953. ALCUMI DATI SULLA STRUTTURA SUBMICROSCOPICA DELLE FIBRE DI TENSIONE DI UN CAMPIONE DI LEGNO DI PIOPPO. [SOME DATA ON THE SUBMICROSCOPIC STRUCTURE OF TENSION-WOOD FIBRES FROM A SAMPLE OF POPLAR WOOD.] Atti dell'Accademia Nazionale dei Lincei (Ser. 8), Roma 14(2): 315-22. 6 refs. [It.]

811.59

Wallin, W. B. 1954. WETWOOD IN BALSAM POPLAR. Minn. For. Note No. 28, 2 pp.

812.7

Giordano, G., and Curro, P. 1962. EFFECT OF TEMPERATURE ON THE STRENGTH PROPERTIES OF WOOD IN STATE OF TOTAL SATURATION. Proc., 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2 (2), Sect. 41/12, 12 pp. 8 refs. [E.e.]

813 WOOD CHEMISTRY

Bagrova, R. H., Balakina, G. P., and Kozlov, V. N. 1962. [CHEMICAL COMPOSITION OF THE WOOD OF POPULUS BALSAMIFERA IN THE URALS.] Lesn. Z., Arhangel'sk 5(3): 155-9. 14 refs. [Russ.]

Jayme, G., and Harders-Steinhauser, M. 1950. UBER DIE CHEMISCHE ZUSAMMENSETZUNG DES ZUGHOLZES IN EINEM PAPPELHOLZ. [CHEMICAL COMPOSITION OF TENSION WOOD IN A POPLAR.] Papier, Darmstadt 4(7/8): 104-13. 23 refs. [G.g.]

813.1

Runger, H. G., and Klauditz, W. 1953. UBER BEZIEHUNGEN ZWISCHEN DER CHEMISCHEN ZUSAMMENSETZUNG UND DEN FESTIGKEITSEIGENSCHAFTEN DES STAMMHOLZES VON PAPPELN. [RELATIONSHIPS BETWEEN THE CHEMICAL COMPOSITION OF POPLAR STEMWOOD AND ITS STRENGTH PROPERTIES.] Holzforschung, Berlin 7(2/3): 43-58. 40 refs. [G.g.e.]

813.11

Brown, S. A. 1961. STUDIES OF LIGNIN BIOSYNTHESIS USING ISOTOPIC CARBON. IX. TAXONOMIC DISTRIBUTION OF THE ABILITY TO UTILIZE TYROSINE IN LIGNIFICATION. Canad. J. Bot. 39(2): 253-8. 12 refs.
Presents and discusses results of tests of the ability to utilize L-tyrosine as a lignin precursor in 21 species (including Populus balsamifera and Caragana arborescens) representing 7 families of monocotyledons and 5 of dicotyledons. Only grasses were able to convert L-tyrosine and L-phenylalanine to lignin with equal efficiency.

———— and Neish, A. C. 1955. STUDIES OF LIGNIN BIOSYNTHESIS USING ISOTOPIC CARBON. IV. FORMATION FROM SOME AROMATIC MONOMERS. Canad. J. Biochem. Physiol. 33 (6): 948-62. 37 refs.
Deals mainly with lignin biosynthesis in wheat, but also contains tabulated data on conversion of labelled compounds to lignin in Acer negundo, Populus balsamifera, and Caragana arborescens.

841.21

Chiani, R. G. 1961. [PRESERVATION OF POPLAR AND WILLOW BOARDS.] Foll. Tec. For. Adm. Nac. Bosques, B. Aires No. 14, 18 pp. [Span.]

841.3

Tinto, J. C. 1960. IMPREGNACION DE POSTES PARA USO RURAL. EXPERIENCIAS REALIZADAS EN LA ARGENTINA CON MADERAS DE ESPECIES FORESTALES CULTIVADAS. [PRESERVATION OF POSTS FOR RURAL PURPOSES. TESTS CARRIED OUT IN ARGENTINA WITH WOODS OF INTRODUCED FOREST SPECIES.] Foll. Tec. For. Adm. Nac. Bosques, B. Aires No. 5, 13 pp. [Span.span.]

———— 1961. [PRELIMINARY RESULTS OF DURABILITY TESTS WITH IMPREGNATED POSTS AND VINE PROPS.] Foll. Tec. For. Adm. Nac. Bosques, B. Aires No. 15, 12 pp. [Span.span.]
Presents an interim report on graveyard tests established in 1954.

852.1

Harzmann, L. J. 1957. DAS HOLZ ANBAUWURDIGER SCHWARZPAPPELHYBRIDEN. [THE WOOD OF WORTHWHILE BLACK POPLAR HYBRIDS.] Holz-Zbl. 83(123): 1503-6. 17 refs. [G.g.]

852.16

Larsen, C. M. 1955. COMPTE RENDU D'UNE ETUDE SUR LE BOIS PELUCHEUX DU PEUPLIER BELGE EN CONSIDERATION DE SON ROLE DANS L'INDUSTRIE ALLUMETTIERE. [A STUDY OF "WOOLINESS" OF BELGIAN POPLAR IN RELATION TO ITS USE AS MATCH STOCK.] Spec. Pap. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 101-14. [F.]

P. CANADENSIS TO P. DAVIDIANA

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

160.29

Klopping, H. L., and Kerk, G. J. M. van der 1951. ANTIFUNGAL AGENTS FROM THE BARK OF POPULUS CANDICANS. Nature, Lond. 167(4259): 996-7. 6 refs.
More detailed study of the bark of P. candicans resulted in the isolation of two actively fungistatic substances, benzyl gentisate and another not identified but very similar to pentatriacontene-17.

161.7

Eisbacher, H. 1962. ANWENDUNG DER KRYOSKOPIE IN DER FORSTLICHEN FORSCHUNG. [THE USE OF CRYOSCOPY IN FOREST RESEARCH.] Proc. 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2(1), Sect. 23/27, 3 pp. [G.g.e.f.]

164.3

Ruggeri, C. 1963. [ANATOMICAL DIFFERENCES IN THE ROOTS OF SOME EURAMERICAN POPLAR HYBRIDS.] Pubbl. Cent. Sper. Agric. For., Roma 6: 131-40. 6 refs. [It.it.e.e.]
Of seven clones investigated, only "I 214" showed any striking difference, being distinguished by the constant presence of pith and the highest percent of bark.

164.5

Broekhuizen, J. T. M. 1961. VERANDERINGEN IN DE BLADVORM VAN ENIGE POPULIERKLONEN GEDURENDE DE VEGETATIEPERIODE. [VARIATIONS IN THE LEAF SHAPE OF SOME POPLAR CLONES DURING THE GROWTH SEASON.] Commun. Inst. For. Res. Agric. Univ. Wageningen No. 3, 35 pp. 4 refs. [Du.e.]

Fortunatov, I. K. 1949. MORFOLOGICOSKOE VYRAZENIE VOZRASTE POBEGOV U TOPOLJA RAZNOLISTNOGO. [MORPHOLOGICAL EXPRESSION OF SHOOT AGE IN POPULUS DIVERSIFOLIA.] Dokl. Akad. Nauk SSSR 64(3): 393-6. [Russ.]
A study of leaf-shape variation on various types of shoot.

164.9

Sauer, E. 1956. STACHELAHNLICHE BILDUNGEN BEI EINEM BASTARD ZWISCHEN ZWEI BALSAMPAPPELN. [THORN-LIKE FORMATIONS ON A HYBRID BALSAM POPLAR.] Z. Forstgenet. 5(4): 103-4. [G.e.f.]
Describes thorn-like outgrowths on the corky ridges of the internodes on one seedling derived from the artificial cross Populus candicans × P. trichocarpa. [See also translation Oxford No. 237S.]

———— 1956. THE THORN-LIKE FORMATION ON A HYBRID OF TWO BALSAM POPLARS. Transl. U. S. For. Serv. For. Prod. Lab., Madison No. 402, 3 pp. 1960.
Transl. by D. Pronin from Z. Forstgenet. 5(4): 103-4. [G.]

165.3

Koltay, G., and Kopecky, F. 1954. OSHONOS NYARAINK LEROMLOTT OROKLOTTSEGENEK MEGJAVITASA. [IMPROVEMENT OF THE DETERIORATED INDIGENOUS STOCK OF POPLAR IN HUNGARY.] Erdesz. Kutatas., Budapest No. 2: 65-86. 15 refs. [Hu.]

Muller, R. 1957. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE FUR DEN ANBAU IN DEUTSCHLAND. LA. GRUNDLAGEN DES SORTENBEGRIFFS. LB. EIGENSCHAFTEN DER ALTSTAMMSORTEN. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS FOR CULTIVATION IN GERMANY. 1A. THE BASES OF THE CONCEPT OF 'VARIETY' 1B. THE CHARACTERISTICS OF THE 'OLD STOCK VARIETIES'.] Holz-Zbl. 83 (45; 73/74): 611-3; 939-43. 67 refs. [G.g.]

165.41

Bugala, W. 1951. EURO-AMERYKANSKIE MICSZANCE TOPOLI CZARNYCH, ICH ZNACZENIE ORAZ KROTKI PRZEGLAD DOTYCHCZASOWYCH OSIAGNIEC HODOWLI TOPOLI W ZSRR. [EURO-AMERICAN HYBRIDS OF BLACK POPLARS, THEIR PRACTICAL VALUE, AND A SHORT REVIEW OF ACHIEVEMENTS TO DATE IN POPLAR BREEDING IN THE USSR.] Sylwan 95(3/4): 324-38. 24 refs. [Pol.e.]

Kopeczky, F. 1956. A SZURKENYAR TELEPITESENEK GENETIKAI KERDESEI. [THE GENETIC PROBLEMS OF GREY POPLAR PLANTINGS.] Erdo 5(1): 23-9. [Hu.]
From abstr. in Hung. Agric. Rev. 5(2):9. 1956. [E.]

Seitz, F. W. 1954. UBER DEN SELBSTUNGS-UND KREUZUNGSERFOLG BEI VERWENDUNG DES POLLENS DER ZWITTRIGEN GRAUPAPPEL VON DILLINGEN. [RESULTS OF SELFING AND CROSSING USING POLLEN OF THE DILLINGEN ANDROGYNOUS GREY POPLAR.] Abstr. in Z. Forstgenet. 3(6): 141. [G.]

165.42

Seitz, F. W. 1954. UBER DAS AUFTRETEN VON TRIPLOIDEN NACH DER SELBSTUNG ANOMALER ZWITTERBLUTEN EINER GRAUPAPPELFORM. [THE OCCURRENCE OF TRIPLOIDS AFTER SELF-POLLINATION OF ANOMALOUS ANDROGYNOUS FLOWERS OF A GREY POPLAR.] Z. Forstgenet. 3(1): 1-6. 13 refs. [G.g.e.]

165.43

Sekawin, M. 1963. [STUDY OF AN ARTIFICIALLY OBTAINED POPLAR TETRAPLOID AND ITS PROGENY.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-1/4, 11 pp. 7 refs. [F.f.]
The poplar, I 438 p, obtained by colchicine treatment from I 154, was of poor form and vigor, but much more fertile than I 154, and its fibre dimensions were superior. Its progeny, all triploid, were intermediate between their male tetraploid and female diploid parent.

165.5

Vojtus, M. 1961. O NIEKTORYCH TYPOCH BIELYCH TOPOL'OV (POPULUS ALBA L. A POPULUS CANESCENS SM.) V PODUNAJSKYCH LUZNYCH LESOCH CSSR. [SOME TYPES OF WHITE POPLARS (P. ALBA AND P. CANESCENS) IN THE DANUBE FLOOD-PLAIN FORESTS OF CZECHOSLOVAKIA.] Lesn. Cas. 7(3): 161-74. 8 refs. [Slovak.russ.g.]

165.53

Wettstein, W., and Vieghofer, L. 1958. PHYSIOLOGISCHE UNTERSCHIEDE MORPHOLOGISCH NICHT UNTERSCHEIDBARER PAPPELKLONE. PRUFUNGSERGEBNISSE DER SOG. DRAPAL-PAPPEL. [PHYSIOLOGICAL DIFFERENCES BETWEEN MORPHOLOGICALLY INDISTINGUISHABLE POPLAR CLONES. RESULTS OF EXPERIMENTS WITH THE SO-CALLED DRAPAL POPLAR.] Holzforschung, Berlin 11(5/6): 139-42. 2 refs. [G.g.e.]

165.62

Marcet, E. 1960. BEITRAG ZUR FRUHDIAGNOSE VON TIEF- UND HOCHLAGENSORTEN BEI SCHWARZPAPPELHYBRIDEN. [TESTS FOR EARLY SELECTION OF BLACK POPLAR HYBRIDS SUITABLE FOR LOW OR HIGH ALTITUDES.] Schweiz. Z. Forstw. 111(8): 428-40. 2 refs. [G.f.]

165.72

Kobendza, R. 1953. CZYM JEST TOPOLA ROGALINSKA? [WHAT IS POPULUS ROGALINENSIS?] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 9: 153-66. 3 refs. [Pol.russ.e.]

Morelli, A. 1960. [THE CULTIVAR B1M SELECTED AT THE POPLAR BREEDING CENTRE OF VILLANUOVA SOLARO (CUNEO).] Agricoltura Delle Venezie, Venezia 14(12): 490-508. [It.]
Describes its sex (male), habit, nursery cultivation, wood properties, health, increment, etc. Data from ordinary and "linear" plantations aged 2 to 14 years from planting indicate that weights of green stemwood of ca. 15 quintals/tree or 4200/ha. at 6 × 6 m. spacing are obtained. Though occasionally doing well on poorer sites, it is best for good ones.

Saatcioglu, F. 1956. BOZKAVAK (POPULUS CANESCENS SMITH) MELEZINIM SUN'I CAPRAZLAMA METODIYLE ELDE EDILMESI. [ARTIFICIAL PRODUCTION OF POPULUS CANESCENS BY CROSSING.] Istanbul Univ. Orm. Fak. Derg. 6(2): 70-91. 13 refs. [Turk.g.g.]
Gives details of the laboratory hybridization and culture of P. alba × P. tremula and P. tremula × P. alba, the early nursery

growth of which was 20% greater than selfed P. alba. Leaves of the two crosses and of pure P. alba are illustrated.

165.72/73

Bogdanov, P. L. 1958. NOVYE GIBRIDY TOPOLEJ. [NEW POPLAR HYBRIDS.] Lesn. Hoz. 11(3): 85-6. [Russ.]
Brief notes on Populus suaveolens × P. 'canadensis'—the "Leningrad poplar," and a "vegetative hybrid" taken from buds at the graft union of P. suaveolens and P. 'canadensis'. Both are said to be fast-growing, and resistant to cold, and the "vegetative hybrid" is not susceptible to leaf rust.

176.1

Boom, B. K. 1957. POPULUS CANADENSIS MOENCH VERSUS P. EURAMERICANA GUINIER. Acta Bot. Neerland. 6(1): 54-9. 16 refs. [E.e.]
Upholds the validity of the name P. × canadensis Moench, rejecting P. × euramericana Guinier, for the hybrids of P. deltoides · P. nigra.

Broekhuizen, J. T. M. 1960. SOME NOTES ON THE IDENTIFICATION AND NOMENCLATURE OF POPLARS. Commun. Inst. For. Res. Agric. Univ. Wageningen No. 1, 9 pp. 8 refs. [E.]

Dzekov, S. 1960. SISTEMATISKI POLOZAJ, GEOGRAFSKE I EKOLOSKE OSOBINE, KAO I SUMSKO-UZGOJNA SVOJSTVA DOMACE SIVE TOPOLE (P[OPULUS] CANESCENS SM.) U NR MAKEDONIJI. [SYSTEMATIC POSITION, GEOGRAPHICAL AND ECOLOGICAL CHARACTERISTICS, AND PROPERTIES AS A FOREST TREE AND IN PROPAGATION, OF P. CANESCENS IN MACEDONIA.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 2: 3-38. 20 refs. [Serb.f.]

Frontera Marques, B. 1955. LE PEUPLIER BLANC D'ALFAMBRA. [THE WHITE POPLAR OF ALFAMBRA.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-V Add. 7, 5 pp. [F.]
Describes a poplar (probably P. canescens) that occurs in some abundance in this region of aragon. It is recommended that it should be tried for planting on cold sites and alkaline soils in other parts of Spain. It suckers freely.

Gerhard, H. 1957. DIE GRAUPAPPEL IN SCHLESWIG. [POPULUS CANESCENS IN SCHLESWIG.] Allg. Forstzeitschr. 12(27/28): 333-6. 5 refs. [G.]
Discusses the history of the species and concludes that the specimens found in Schleswig are, with but few exceptions, from a single clone; also mentions propagation by root and shoot cuttings, grafting, layering, and suckers.

[International: FAO/Int. Poplar Comm.] 1959. NOMENCLATURE AND REGISTRATION [OF POPLAR HYBRIDS OF THE SECTION AIGEIROS.] [Docum.] 10th Sess. Int. Poplar Comm. 1959 No. FAO/CIP/97, 5 pp. [E.]
Includes an annexe by J. Pourtet, tracing the history of nomenclature refuting recently advanced arguments in favor of Populus canadensis, and concluding that the correct name for the group should be Populus × euramericana Guinier [cf. Boom, 1957, this subject classification].

Issler. 1929. NOTE ON IDENTIFICATION OF P. CANESCENS. Biol. Abstr. 32: 510.

Jovanovic, B., and Tucovic, A. 1960. TAKSONOMSKA PROUCAVANJA JASIKE (POPULUS TREMULA L.) ODNOSNO T.ZV.BAHOFENOVE TOPOLE NA DELIBLATSKOJ PESCARI. [TAXONOMIC STUDIES ON ASPEN (P. TREMULA) WITH REFERENCE TO THE SO-CALLED BACHOFEN POPLAR ON THE DELIBLATO SANDS.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 1: 5-41. 24 refs. [Serb.serb.g.]

Mirbach-Harff. 1933. P. CANADENSIS IN GERMANY. Mitt. Dtsch. Dendrol. Ges. 45: 308-10.

Muller, R. 1958. DER WERT DER WIRTSCHAFTSPAPPELSORTEN (SCHWARZPAPPELBASTARDE). [THE VALUE OF POPULUS NIGRA HYBRIDS.] Forst- u. Holzw. 13(6): 109-11. [G.]
A general discussion of the nature of 'old stock varieties', particularly the significance of the climatic range of the parents on disease resistance, growth, etc., advocating more widespread use of some, and stressing the need for systematic selective breeding of new varieties. [Cf. Muller, 1957, P. canadensis to P. davidiana, 165.3.]

———— 1958. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIE. DIE 'ECKHOF'-PAPPEL. IIF. DIE 'EUKALYPTUS'-PAPPEL. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIE. THE 'ECKHOF' POPLAR. IIF. THE 'EUCALYPTUS' POPLAR.] Holz-Zbl. 84(76; 77): 993; 1009-10. 11 refs. [G.]
The 'Eckhof' poplar includes some clones distributed as P. 'regenerata Huttenfeld'. Varieties going under the names 'regenerata erecta' and 'virginiana' are identified with the 'Eucalyptus' poplar.

———— 1958; 1959. ALSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIH, I, K-M. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIH, I, K-M.] Holz-Zbl. 84(105; 124; 128): 1333-4; 1577-8; 1635-6; 85(50; 62): 663-4; 822-3. Many refs. [G.]
Further installments, as follow: (h) The 'grandis' poplar (includes clones distributed as 'carrieriana', 'carrieri' (from England), 'wislizenii' and 'regenerata'). (i) The 'gelrica' poplar. (k) The 'Leipzig' poplar. (l) The Bavarian 'Flachslanden' poplar, considered highly resistant to rust, canker, and extremes of temperature, and recommended for cultivation outside Bavaria. (m) The 'missouriensis Holland' poplar, which resembles P. × robusta; listed by the International Poplar Commission as P. deltoides cv. 'missouriensis imp. hollandaise', but considered to be a hybrid, not identical with P. deltoides subsp. missouriensis.

———— 1959. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIN, O. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIN, O.] Holz-Zbl. 85(114;138):1521-3; 1858-60. 22 refs. [G.]
(n) The Neupotz' poplar of Baden and the Palatinate, considered the most valuable variety on the flood-plains in the region, is distinguished from P. × regenerata, and the cultivar going under the name of P. "regenerata" in Western Europe, has been named poplar, which is considered identical with clones going under the name of P. "regenerata" in Western Europe, has been named 'Forndorf' by the German Pappelmarkenetikett authority to distinguish it clearly from 'Regenerata Deutschland'. Synonyms, trade names, and identification in the wider 'Regenerata' group, comprising "Forndorf," "Regenerata Deutschland," "Grandis" and "Leipzig," are tabulated. The cultivar is considered hardy, and resistant to canker but not to rust, and is recommended for sites that are climatically somewhat adverse (e.g. in Schleswig Holstein).

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIP. DIE 'MARILANDICA'-PAPPEL. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIP. THE 'MARILANDICA' POPLAR.] Holz-Zbl. 86(31): 477-9. 23 refs. [G.]

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIQ. DER SORTENFORTSCHRITT IN DER PAPPELWIRTSCHAFT. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIQ. BETTER VARIETIES FOR POPLAR GROWERS.] Holz-Zbl. 86 (56): 791-2. [G.]

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIR. DIE 'SEROTINA'-PAPPEL. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIR. THE 'SEROTINA' POPLAR.] Holz-Zbl. 86(91): 1283-4, 1286. 15 refs. [G.]

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIS. DIE PAPPEL 'REGENERATA DEUTSCHLAND' = 'HARFFER PAPPEL'. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIS. THE 'REGENERATA DEUTSCHLAND' OR 'HARFF POPLAR'.] Holz-Zbl. 86(98): 1369-70. 23 refs. [G.]

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIT. DIE 'ROBUSTA'-PAPPEL. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIT. THE 'ROBUSTA' POPLAR.] Holz-Zbl. 81(118): 1658-1663. 51 refs. [G.g.]

———— 1961. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIV. NEUSORTEN AUS ALTSTAMMEN UND FREMDE ALTSORTEN. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIV. NEW VARIETIES FROM 'OLD STOCKS', AND FOREIGN 'OLD STOCK' VARIETIES.] Holz-Zbl. 87(21): 319-24. 21 refs. [G.]

———— and Sauer, E. 1958. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE FUR DEN ANBAU IN DEUTSCHLAND. II. DIE EINZELNEN PAPPELSORTEN. (A) EINLEITUNG: UBERSICHT DER MERKMALE DER SCHWARZPAPPELBASTARDE. (B) DIE 'DROMLING'-PAPPEL. (C) DIE 'LONS-PAPPEL. (D) DIE 'BRABANTICA'-PAPPEL. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS FOR CULTIVATION IN GERMANY. II. THE INDIVIDUAL VARIETIES. (A) INTRODUCTION. (B) THE 'DROMLING' POPLAR. (C) THE 'LONS' POPLAR. (D) THE 'BRABANTICA' POP-

LAR.] Holz-Zbl. 84(19; 31; 55; 58/59): 283-5; 437-9; 721; 775-8. 18 refs. [G.]

Pavari, A. 1937. ALCUNE OSSERVAZIONI SUL PIOPPO DEL CANADA. [SOME NOTES ON THE CANADIAN POPLAR.] In Atti del Convegno di Pioppicoltura 1937: 55-60. [It.]

Pohl, Z., and Stecki, Z. 1959. TOPOLA SZARA W WIELKOPOLSCE. [THE GREY POPLAR IN WIELKOPOLSCE [NATIONAL PARK?].] Arbor. Kornickie, Poznan No. 4: 109-22. 18 refs. [Pol.russ.e.e.]

Poskin, A. 1947. LES VARIETES ET LES TYPES DE PEUPLIER DU CANADA. [THE VARIETIES AND TYPES OF "CANADIAN" POPLAR.] Bull. Soc. For. Belg. 54(11): 377-91. [F.]

Redman, K. 1942. NOMENCLATURE CONFUSION OF POPULUS CANDICANS AITON. J. Amer. Pharm. Ass. (Sci. Ed.) 31(5): 140-1. Bblg.

Rehder. 1931. NOTE ON P. CATHAYANA. J. Arnold Arbor. 12: 59.

[Rumania: Rev. Padurilor] 1957. [BREEDING AND GROWING HYBRID BLACK POPLARS IN RUMANIA.] Rev. Padurilor 1957(5): 291-314. [Rum.russ.g.f.e.]

Rusch, J. 1959. DAS VERHALTNIS VON TRANSPIRATION UND ASSIMILATION ALS PHYSIOLOGISCHE KENNGROSSE, UNTERSUCHT AN PAPPELKLONEN. [AN INVESTIGATION WITH POPLAR CLONES ON THE USE OF THE RELATIONSHIP OF TRANSPIRATION AND ASSIMILATION AS A PHYSIOLOGICAL INDEX.] Zuchter 29(8): 348-54. 41 refs. [G.g.]

Sauer, E. 1958. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIG. BESTIMMUNGSTABELLE FUR DIE BAUMSCHULPFLANZEN DER ALTSORTEN. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIG. KEY TO NURSERY PLANTS.] Holz-Zbl. 84(89): 1149 [G.]
Contains a dichotomous key to the 16 main 'old stock varieties' and some less common clones, based on the criteria previously discussed, and a second key showing the distinguishing characters of the 16 main varieties in relation to those resembling them most closely.

———— 1960. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIU. VERFAHREN UND MOGLICHKEITEN DER SORTENPRUFUNG. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS. IIU. METHODS AND POSSIBILITIES OF VARIETY TESTING.] Holz-Zbl. 86 (150): 2129 -32. 13 refs. [G.]

Schwarz, H. 1951. BEITRAG ZUR KENNTNIS DER PAPPEL VON RAVERDEAU. [POPULUS CANADENSIS VAR. ERECTA.] Ost. Vjschr. Forstw. 92(4): 276-80. 11 refs. [G.]
A brief description of the tree and its silvicultural requirements.

Soules, B. 1962. [CHARACTERISTICS OF EURAMERICAN POPLAR CLONES.] Das. Chron. 4(3): 113-8. [Gk.]
Gives salient characters for 12 clones.

Tubeuf. 1933. NOTE OF P. CANESCENS HYBRID. Biol. Abstr. 7: 1729.

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Grohn, W. [1951.] DIE GRAUPAPPEL IN SCHLESWIG-HOLSTEIN. [POPULUS CANESCENS IN SCHLESWIG-HOLSTEIN.] Mitt. Dtsch. Dendrol. Ges. (Jb. 1950) No. 56: 64-6. [G.e.]

[Italy: Agricoltore Bresciano] 1962. [B2F, A POPLAR VARIETY OF GREAT MERIT.] Agricoltore Bresciano, Brescia 11(27): 2. [It.]
Describes this (patented) cultivar, thought to be a hybrid between a "Carolina" and a "Canadian" poplar. It has a well formed, cylindrical stem, and superior wood properties, is adapted to a wide range of sites, and resistant to most common poplar diseases.

Schwerin, v. 1919. POPULUS CHARKOWIENSIS, THE QUICKEST GROWING AND LIGHTEST WOODED OF ALL POPLARS. Mitt. Dtsch. Dendrol. Ges. 28: 143.

181.1

Anonymous. 1896. THE CANADIAN POPLAR IN CANADA. Bull. Soc. For. Belg. 3: 696.

181.2

[France: Serv. Cult. Etud. Peuplier et Saule] 1961. CLIMATOLOGIE ET POPULICULTURE. [CLIMATOLOGY AND POPLAR GROWING.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris 1961(1; 2): 6-37; 7-49. [F.]

181.2/3

Pourtet, J. 1960. NOTE SUR LES VARIATIONS INDIVIDUELLES D'ACCROISSEMENT DES PEUPLIERS D'UNE PLANTATION MONOCLONALE. [INDIVIDUAL GROWTH VARIATION OF POPLARS IN A MONOCLONAL PLANTATION.] Rev. For. Franc. 12(1): 55-7. [F.f.]
Three plots, each of a single clone, planted 10 and 7 years ago in apparently uniform conditions, show increasing differences between trees within the plots. Trees appear sensitive to microvariations in environment that instruments cannot record. The clones were 'robusta', 'virginie de frignicourt' and 'I-214'.

181.21

Gunther, H. 1961. BEOBACHTUNGEN UBER DIE SCHATTENERTRAGLICHKEIT VERSCHIEDENER PAPPELSORTEN. [SHADE TOLERANCE OF DIFFERENT POPLAR VARIETIES.] Wiss. Abh. Dtsch. Akad. Landw-Wiss., Berlin No. 52 (Beitr. Pappelforsch. No. 6): 37-52. 3 refs. [G.g.russ.e.]

181.3

Rohrig, E. 1959. UNTERSUCHUNGEN UBER DAS JUGENDWACHSTUM VON SCHWARZPAPPEL-HYBRIDEN AUF VERSCHIEDENEN STANDORTEN. [EARLY GROWTH OF BLACK POPLAR HYBRIDS ON DIFFERENT SITES.] Silvae Genet. 8(1): 24-30. 17 refs. [G.g.e.f.]

181.31

Pourtet, J., and Turpin, P. 1958. L'INFLUENCE DE LA PROFONDEUR DU PLAN D'EAU ET DU TRAVAIL DU SOL SUR LA CROISSANCE DES PEUPLIERS. [THE INFLUENCE OF DEPTH OF WATER-TABLE, AND SOIL CULTIVATION ON THE GROWTH OF POPLARS.] Rev. For. Franc. 1958 (6): 415-8. [F.]

181.319

Roosen, P. 1955. LA TENEUR EN EAU DES TIGES DE PEUPLIERS EURAMERICAINS EN BELGIQUE. [THE WATER CONTENT OF STANDING STEMS OF HYBRID BLACK POPLARS IN BELGIUM.] Spec. Pap. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 53-66. 8 refs. [F.]

———— 1957. LA TENEUR EN EAU DES TIGES DE PEUPLIERS EURAMERICAINS EN BELGIQUE. [WATER CONTENT OF STEMS OF HYBRID BLACK POPLARS IN BELGIUM.] Bull. Inst. Agron. Gembloux 25(1/2): 179-97. 8 refs. [F.f.]

181.32

Giordano, A. 1959. NOTA PEDOLOGICA SUI TERRENI DELLA TENUTA NOBILI-NICHETTI. [A PEDOLOGICAL NOTE ON THE SOILS OF THE NOBILI-NICHETTI ESTATE.] Cellulosa e Carta 10(9): 17-20. [It.f.e.g.]
Soil profiles were investigated, to determine the differences of soil, if any, between vigorous and poor poplar stands on deep sands. Growth was found to be closely correlated with humus content.

181.341

Giulimondi, G. 1960. RICERCHE PRELIMINARI SULLA NUTRIZIONE MINERALE DEL PIOPPO A MEZZO DELL'ANALISI FOLIARE. [THE USE OF FOLIAR ANALYSIS FOR THE INVESTIGATION OF MINERAL NUTRITION OF POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 4: 231-45. 12 refs. [It.it.e.]

———— 1962. EFFECT OF HUMIC ACID ON THE ROOTING AND GROWTH OF POPLARS AND EUCALYPTS. Proc. 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2(1), Sect. 23/6, 7 pp. 19 refs. [E.e.]

Krauss, H. H. 1959. BEITRAG ZUR KENNTNIS DER WECHSELBEZIEHUNGEN ZWISCHEN DEN HAUPTNAHRSTOFFEN STICKSTOFF, PHOSPHORSAURE UND KALI BEI DER DUNGUNG VON FORSTPFLANZEN. [THE INTERACTION OF THE MAIN NUTRIENTS N, P AND K IN THE FERTILIZING OF FOREST PLANTS.] Arch. Forstw. 8(6/7): 592-649. 22 refs. [G.g.russ.e.]

Liekens, H. 1960. GEBREKSVERSCHIJNSELEN EN GROEIVERSCHILLEN BIJ POPULIERENSTEKKEN IN VERBAND MET DE HOOFDELEMENTEN IN DE VOEDING. [SYMPTOMS OF NUTRIENT DEFICIENCY AND DIFFERENCES

IN GROWTH OF POPLAR CUTTINGS IN RELATION TO THE MAIN ELEMENTS IN THE NUTRIENT SOLUTION.] Agricultura, Louvain 8(4): 663-87. 15 refs. [Du.du.f.e.]

181.342

Jaro, Z. 1963. [STUDIES OF POPLAR SITES IN PUSZTAVACS.] Erdo 12(4): 145-50. [Hu.russ.g.]

Liani, A. 1960. DETERMINAZIONE DELLA CAPACITA DI SCAMBIO CATIONICO DELLE RADICI DI PIOPPO. [DETERMINATION OF THE CATION EXCHANGE CAPACITY OF POPLAR ROOTS.] Pubbl. Cent. Sper. Agric. For., Roma 4: 127-38. 36 refs. [It.it.e.]

181.52

Gamble. 1897. FLOWERS OF P. CILIATA IN INDIA. Indian For. 23: 256.

181.521

Sauer, E. 1954. BEOBACHTUNGEN AN ZWITTRIGEN PAPPELN. [OBSERVATIONS ON ANDROGYNOUS POPLARS.] Z. Forstgenet. 3(5): 89-91. 6 refs. [G.g.e.]
A study of the androgynous flowers of a young Populus tremula at Stuttgart. Mention is also made of the occurrence of androgynous flowers on an adult P. alba (or possibly P. alba × P. canescens) and a young P. candicans. [Cf. Seitz, 1954, P. canadensis to P. davidiana, 165.42.]

181.525

Marjai, Z. 1956. NYARMAG CSIRAZASFIZIOLOGIAI VIZSGALATOK. [GERMINATION-PHYSIOLOGICAL INVESTIGATIONS ON POPLAR SEEDS.] Erdesz. Kutatas., Budapest 1956(3): 95-109. 13 refs. [Hu.russ.e.g.]

181.61

Sauer, E. 1959. UBER DIE BEASTUNGSVERHALTNISSE VON 1-JAHRIGEN BAUMSCHULPFLANZEN DER 16 WIRTSCHAFTSPAPPEL-ALTSORTEN. [BRANCHING IN 1-YEAR-OLD NURSERY PLANTS OF 16 OLD-ESTABLISHED COMMERCIAL POPLAR VARIETIES.] Silvae Genet. 8(6): 161-72. 2 refs. [G.g.e.f.]
Number of branches, height of first branch from the ground, length of branches, angle between branch and stem, and height of tree were measured on three individuals of each of 16 varieties of Populus × 'canadensis', and a statistical analysis of the data is presented and discussed.

181.62

Satoo, T., Kunugi, R., and Kumekawa, A. 1956. [MATERIALS FOR STUDIES OF GROWTH IN STANDS. 3. AMOUNT OF LEAVES AND PRODUCTION OF WOOD IN ASPEN (POPULUS DAVIDIANA) SECOND GROWTH IN HOKKAIDO.] Bull. Tokyo Univ. For. No. 52: 33-51. 26 refs. [Jap.jap.e.e.]

181.64

Petrescu, L. 1956. INFLUENTA SCHEMELOR DE PLANTARE ASUPRA SECTIUNILOR TRANSVERSALE LA PLOPII NEGRI HIBRIZI. [THE INFLUENCE OF PLANTING ARRANGEMENT ON CROSS-SECTIONAL FORM OF HYBRID BLACK POPLARS.] Rev. Padurilor 71(8): 509-13. 5 refs. [Rum.russ.g.]
Analysis of stem form in eight plantations showed that the amount of excentricity was directly related to the degree of irregularity in planting rows. In perfectly symmetrical plantations, excentricity, when it occurred, appeared to be always oriented in the same direction, depending upon the prevailing wind.

181.65

Anonymous. 1934. CROISSANCE RAPIDE DU PEUPLIER DU CANADA. [RAPID GROWTH OF CANADIAN POPLAR IN BELGIUM.] Bull. Soc. For. Belg. 41: 205. [F.]

Miegroet, M. van. 1961. ETUDE MORPHOLOGIQUE DE QUELQUES TYPES DE PEUPLIERS AU STADE JUVENILE. [A MORPHOLOGICAL STUDY OF SOME TYPES OF POPLAR IN THE JUVENILE STAGE.] Bull. Soc. For. Belg. 68(4): 225-39. [F.]

Ow, L. von. 1957. DER VERLAUF DES JAHRLICHEN HOHENWACHSTUMS VON PAPPELN. [THE SEASONAL RHYTHM OF HEIGHT GROWTH IN POPLARS.] Forst- u. Holzw. 12(12): 202-3. 1 ref. [G.]

181.71

Lassen, E. 1955. EN STOR GRAAPOPPEL. [A LARGE SPECIMEN OF POPULUS CANESCENS.] Dansk Skovforen. Tidsskr. 40(6): 271-8. [Dan.]
Gives the dimensions and increment data of a tree ca. 220 years old (d.b.h. 565 cm., ht. 33 m.), growing near Stenderup; the stem snapped in Aug. 1952 as a result of decay.

181.75

Sebald, O. 1960. UNTERSUCHUNGEN UBER DIE BLATTNERVATURDICHTE VERSCHIEDEN ALTER PAPPELKLONE. [THE VENATION DENSITY OF LEAVES FROM POPLAR CLONES OF DIFFERENT AGES.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 9: 72-4. 11 refs. [G.g.]

181.8

Marcet, E. 1956. DIE PHANOLOGIE ALS BESTIMMUNGSMERKMAL BEI PAPPELSORTEN. [PHENOLOGY AS A DISTINGUISHING CHARACTER OF POPLAR VARIETIES.] Ber. Schweiz. Bot. Ges., Zurich 66: 5-18. 8 refs. [G.g.]

Ruggeri, C. 1960. ATTIVITA CAMBIALE IN POPULUS × EURAMERICANA CV. 'I 214.' [CAMBIAL ACTIVITY IN P. × 'CANADENSIS' CV. 'I 214'.] Pubbl. Cent. Sper. Agric. For., Roma 4: 151-64. 7 refs. [It.it.e.]

Tucovic, A. 1955. EUROAMERICKE TOPOLE (POPULUS EURAMERICANA) U BEOGRADU I OKOLINI. [HYBRID BLACK POPLARS (P. × EURAMERICANA) IN BELGRADE AND ITS ENVIRONS.] Glasn. Sum. Fak., Beograd No. 10: 129-47. 30 refs. [Serb.g.g.]

187 VEGETATION TYPES

Panin, P. S. 1960. NEKOTORYE OSOBENNOSTI RASTITEL'NOGO POKROVA KASGARII. [SOME FEATURES OF THE VEGETATION OF THE KASHGAR [SINKIANG-UIGHUR AUTONOMOUS REGION. CHINA].] Bot. Z. 45 (4): 583-8. [Russ.]
Describes three main soil/vegetation zones, and the tree vegetation, which consists mainly of Populus diversifolia and Tamarix sp.

2 SILVICULTURE

Bernardini, F. 1948. LA COLTURA DEL PIOPPO DEL CANADA NELLE GOLENE APERTE DEL PO. [THE CULTIVATION OF "CANADIAN" POPLAR ON THE UNENCLOSED MUDBANKS OF THE RIVER PO.] Ital. Agric. 85(1): 55-63. 4 refs. [It.]

Gerhard, H. 1959. DIE GRAUPAPPEL UND IHRE ANBAUMOGLICHKEITEN IN NORDWEST DEUTSCHLAND. [POSSIBLE USES FOR POPULUS CANESCENS IN NORTHWEST GERMANY.] Holzzucht, Reinbek 13(4): 25-7. [G.]
Recommends the species for gaps in the forest, for wind protection, roadsides, etc., and discusses propagation, systematic position, etc. [Cf. Grohn, 1955, P. canadensis to P. davidiana, 266.]

[Germany: Mitt. Dtsch. Dendrol. Ges.] 1913. REVIEW OF MAJERSZKY. CULTURE OF P. CANADENSIS. (Hungry.) Mitt. Dtsch. Dendrol. Ges. 28: 342.

Gutschick. 1937. THE SILVICULTURAL TREATMENT OF CANADIAN POPLAR. Wiener Allg. Forst- u. Jagdztg. 55(13): 59. [G.]

Kern. 1905. CULTIVATION OF P. CANADENSIS. Mitt. Dtsch. Dendrol. Ges. 14: 442.

Peschaut. 1931. CULTIVATION OF P. CANADENSIS IN LIGHT OF PRESENT FORESTRY CONDITIONS. Wiener Allg. Forst- u. Jagdztg. 49: 200.

Schelling, E. von, and Rohmeder, E. 1944. DIE KANADISCHE PAPPEL IM GRAFLICH VON PREYSINGSCHEN FORSTREVIER MOOR. ["CANADIAN" POPLAR ON THE MOOR OF THE VON PREYSING FOREST DISTRICT.] Dtsch. Forstw. 1944(9/10; 13/14), 4 pp. [G.]
A brief history of the stands of Populus 'canadensis' in this area

and a short account of the present state of the stands with notes on propagation maintenance, protection, and yield.

Schmitz-Lenders, B. 1956. MEIN PAPPEL-TESTAMENT. [MY POPLAR TESTAMENT.] J. D. Sauerlanders Verlag, Frankfurt a./M. 188 pp. 87 refs. [G.]

Seth, S. K., and Desarker, B. K. 1960. POPLAR CULTIVATION. Indian For. 86(1): 21-7. 19 refs.
A general account of poplar growing in Europe and America, with more detailed notes on the indigenous Indian species, Populus euphratica and P. ciliata.

Walther. 1895. NOTE ON CULTIVATION OF CANADIAN POPLAR IN GERMANY. Allg. Forst- u. Jagdztg. 71: 67-9.

231.5

Clonaru, A. 1960. CONTRIBUTII LA CUNOASTEREA REGENERARII VEGETATIVE A PLOPILOR NEGRI REPEDE CRESCATORI. [THE VEGETATIVE REPRODUCTION OF QUICK-GROWING BLACK POPLARS.] Lucrari Stiintifice, Institutul Politehnic, Orasul Stalin (Ser. Silvic.) 4: 115-32. 7 refs. [Rum.russ.f.]

232.1

Anonymous. 1923. P. CANADENSIS IN SWITZERLAND. J. For. Suisse 74: 206.

———— 1929. VALUE OF P. CANADENSIS FOR PLANTING. Dtsch. Forstztg. 44: 4.

Bakkay, L. 1955. A SZURKENYAR SZEREPE AZ ERDOK HOZAMANAK FOKOZASABAN. [THE ROLE OF THE GREY POPLAR IN INCREASING THE YIELD OF FORESTS.] Erdo 4(5): 185-91. [Hu.]
P. canescens, hitherto neglected because its discolored heartwood was not suitable for paper-making, is suitable for fibreboard. Its planting should be encouraged and breeding should aim at the elimination of the heart defect and of bole sweep. From abstr. in Hung. Agric. Rev. 4(3): 7. 1955.

Koltay, G. 1953. CSEMETEKERTJEINK NYARSZAPORITO ANYAGA. [THE POPLAR PLANTING STOCK IN OUR FOREST NURSERIES.] Erdo 2(1): 42-9, 110. [Hung.g.]

Meiden, H. A. van der. 1962. DE PRAKTISCHE BETEKENIS VAN VERSCHILLENDE POPULIERECULTIVARS. [THE PRACTICAL IMPORTANCE OF DIFFERENT POPLAR CULTIVARS.] Ned. Boschb.-Tijdschr. 34(1): 20-8. 12 refs. [Du.e.e.]
The first part discusses general considerations with reference to the cultivars commonly grown in the Netherlands. The second part considers the susceptibility of Populus × serotina to disease and especially to crown dieback (primary cause unknown), which makes it unsuitable for general planting.

———— 1962. DE PRAKTISCHE BETEKENIS VAN VERSCHILLENDE POPULIERECULTIVARS. III, IV. [THE PRACTICAL IMPORTANCE OF DIFFERENT POPLAR CULTIVARS. III, IV.] Ned. Boschb.-Tijdschr. 34(3): 120-30. 11 refs. [Du.e.]

———— 1962. DE PRAKTISCHE BETEKENIS VAN VERSCHILLENDE POPULIERECULTIVARS. V. POPULUS CANADENSIS CV. ROBUSTA. [THE PRACTICAL IMPORTANCE OF DIFFERENT POPLAR CULTIVARS. V. P. × CANADENSIS CV. 'ROBUSTA.'] Ned. Boschb.-Tijdschr. 34(4): 139-44. 11 refs. [Du.e.]
Thirty-five percent of all certified poplar plantations in the Netherlands consist of 'Robusta' (including cvs. 'Zeeland,' 'Bachelieri' and 'Vernirubens'). Its resistance to diseases and wind damage, silvicultural characteristics and wood are briefly discussed.

———— 1962. [THE PRACTICAL IMPORTANCE OF DIFFERENT POPLAR CULTIVARS. VI. POPULUS × CANADENSIS CV. HEIDEMIJ. VII. P. × CANADENSIS CV. SEROTINA ERECTA (= 'REGENERATA').] Ned. Boschb.-Tijdschr. 34(8): 308-19. 18 refs. [Du.e.e.]

———— 1962. [THE PRACTICAL IMPORTANCE OF DIFFERENT POPLAR CULTIVARS. VIII. SOME RARELY-PLANTED CULTIVARS. IX. SUMMARY.] Ned. Boschb.-Tijdschr. 35(1): 14-22. 5 refs. [Du.e.]
VIII. Populus 'canadensis' cvs. I 214 and Keppels glorie (= Serotina de Champagne). IX. A review of the value and properties of the cultivars already discussed, stressing the need to increase the use of cultivars other than 'Gelrica' and 'Robusta,' which make up nearly 60% of poplars planted annually in the Netherlands.

232.11

Benassi, L. 1946. ACCRESCIMENTO IN ALTEZZA DELLE PIANTE DI PIOPPO CANADESE E UNA NORMA COLTURALE. [HEIGHT INCREMENT OF "CANADIAN" POPLAR PLANTS AND A PLANTING STANDARD.] Ital. For. Mont. 1(5): 222-3. [It.]

Chizzali, F. 1957. RESULTADOS DE 5 ANOS DE FORESTACION CON SALICACEAS, EN TIERRA FIRME, EN LA PROVINCIA DE SANTA FE. [RESULTS OF 5 YEARS' AFFORESTATION WITH SALICACEAE ON DRY LAND IN SANTA FE PROVINCE.] Rev. For. Argent. 1(1): 15-25. [Span.]

Georgopulos, A. 1953. SYMBOLE STEN KALLIERGEIA TES LEUKES IDIAITERA STEN HELLADA. [POPLAR CULTIVATION WITH PARTICULAR REFERENCE TO GREECE.] Dasos 7(23/24): 6-32. 17 refs. [Gk.f.]
Includes an account of the striking early development of imported clones (Italian and French) of P. × euramericana in various Greek nurseries and sites; data on survival, height growth, and insect susceptibility are tabulated. The Greek climate favors a long growing season. [Cf. Georgopulos, 1952, Populus sp., 232.43.]

Guerreiro, M. G. 1956. O CULTIVO DO CHOUPO E A IRRIGACAO DE ALEUTEJO. [POPLAR CULTIVATION AND THE IRRIGATION OF LAND SOUTH OF THE TAGUS.] Agros 39(2): 63-74. [Port.]
Discusses the suitability of poplar for this region and presents some figures for timber production from Populus 'euramericana' in Italy.

Jovanovic, S. 1951. PODIZANJE TOPOLOVIH KULTURA. [GROWING POPLARS.] Sumarstvo 4(6): 349-58. [Serb.f.]

Ponticelli, P. 1954. PIOPPICOLTURA MERIDIONALE. [GROWING POPLAR IN THE SOUTH.] Cellulosa e Carta 5(11): 9-11. [It.f.e.]
Describes an experimental plantation of poplar (clone I 214) in the province of Salerno, where poplar has not hitherto been much planted. Particular emphasis is laid on the spacing (6 × 6 m.) which was much wider than usual in central and southern Italy (1.5 × 1.5 m.), staking, and cultivation of garden crops between the rows.

Zappi, C. V. 1958. OBSERVACIONES SOBRE EL COMPORTAMIENTO Y CRECIMIENTO DEL POPULUS EURAMERICANA "MONILIFERO" EN EL DELTA DEL PARANA. [THE BEHAVIOR AND GROWTH OF P. × CANADENSIS "MONILIFERO" IN THE PARANA DELTA.] Rev. For. Argent. 2(4): 123-6. [Span.]

232.13

Bruckmann, H. H. 1957. OBSERVACIONES EPIDOMETRICAS SOBRE ESPECIES E HIBRIDOS DE POPULUS EN EL PARANA MINI, ISLAS DEL DELTA DEL PARANA. [GROWTH STUDIES ON POPLAR SPECIES AND HYBRIDS IN PARANA MINI, ISLANDS OF THE PARANA DELTA.] Rev. For. Argent. 1(4): 136-9. [Span.]

Dathe, A. 1959. DIE ANBAUWURDIGKEIT DER ITALIENISCHEN PAPPELKLONE IN DEUTSCHLAND. [THE SUITABILITY OF THE ITALIAN POPLAR CLONES FOR PLANTING IN GERMANY.] Allg. Forstzeitschr. 14(41): 715-8. [G.g.]

Elsner, F. 1960. ERGEBNISSE DER BAYERISCHEN PAPPELSORTEN-PROBEANBAUTEN 1951. [RESULTS OF THE BAVARIAN POPLAR VARIETY TRIALS, 1951.] Holz-Zbl. 86(49): 700-2. [G.g.]

Georgiev, Z. 1960. O PRODUKTIVNOSTI TOPOLEJ V LESAH BOLGARII. [YIELDS OF POPLARS IN BULGARIA.] Vestn. Sel'.-Hoz. Nauki 5(3): 124-6. [Russ.e.g.f.]
Tabulates data on standing volume and volume c.a.i. for some plantations of Populus × regenerata, P. × marilandica, and P. × serotina at various ages and on various sites in Bulgaria.

Glisic, M. V. 1963. [PRELIMINARY RESULTS OF RAISING FAST-GROWING EURAMERICAN HYBRID POPLARS ON ALLUVIAL SOILS OF LARGE RIVERS.] Sumarstvo 16(1/2): 41-7. 10 refs. [Serb.f.]
Cuttings of P. × regenerata, P. I-214, and P. I-154 planted directly in three sub-plots showed that P. I-154 gives greater height and diameter growth in the first 2 years than P. I-214, and P. I-214 greater than P. × regenerata. Studies are continuing.

Graves, P. F., Hamilton, L. S., and Fedkiw, J. 1958. CAROLINA POPLAR PLANTATION YIELDS 55 CORDS PER ACRE AT 25 YEARS. J. For.

56(1): 38-9.
In spring 1930, 1,000 rooted cuttings were planted at 6 × 6 ft. spacing on a lake-side site in New York State that is flooded for 2-3 weeks each year in spring. After 25 years, 299 survived with a computed b.a./acre of 199.5 sq. ft. and mean d.b.h. of 10.4 in., mean ht. to 4-in. top 52 ft. Trees are of excellent form and natural pruning has been good. The identity of this poplar is uncertain (possibly Populus × eugenei or P. × robusta).

Ienaka, H., and Hatano, K. 1962. DIE BEDEUTUNG DER PHOTOPERIODE FUR DEN ANBAU DER EINGEFUHRTEN BASTARDPAPPELN. [THE IMPORTANCE OF PHOTOPERIOD IN THE GROWING OF INTRODUCED HYBRID POPLARS.] J. Jap. For. Soc. 44(1): 15-8. 4 refs. [G.g.jap.]

Lara, L. F. de S. 1959. ELEMENTOS DE ESTUDO PARA CONHECIMENTO DE ALGUNS "CLONES" DE CHOUPO. [PRELIMINARY STUDIES OF SOME POPLAR CLONES.] Estud. Inform. Serv. Flor. Aquic. Portugal No. 108-A3, 5 pp. [Port.]
Gives the results of a preliminary study of the development of 10 different clones, mainly hybrid black poplars, in the nursery over the first 6 months. Height and diameter measurements of 50 individuals are presented, along with climatic data. The plants were watered weekly.

May, S. 1958. SVILUPPO DI ALCUNI CLONI NEL PIOPPETO SPERIMENTALE DI TORVISCOSA. [DEVELOPMENT OF SOME CLONES IN THE EXPERIMENTAL POPLAR PLANTINGS AT TARVISCOSA.] Cellulosa e Carta 9(2): 9-12. [It.f.e.g.]

Meiden, H. A. van der, and Wolterson, J. F. 1960. HET PROBLEM VAN CULTIVAR EN KLOON BIJ POPULIER. [THE PROBLEM OF [THE CHOICE OF] POPLAR CULTIVARS AND CLONES [FOR MARKETING IN THE NETHERLANDS].] Ned. Boschb.-Tijdschr. 32(5/6): 160-83. 8 refs. [Du.du.e.e.f.]
Reprinted as Korte Meded. Bosbouwproefsta., Wageningen No. 41. 1960.

Miletic, S. 1960. ITALIJANSKI KLONOVI TOPOLA NA PODRUCJU L.S.G. "KOSUTNJAK"—BILJE. [ITALIAN CLONES OF POPLAR IN THE REGION OF THE "KOSUTNJAK" GAME AND FOREST ESTATE AT BILJE [CROATIA].] Topola, Beograd 4(13/14): 14-6. 1 ref. [Serb.f.]
Describes the introduction and performance of Italian clones in Yugoslavia since 1956. Clones 214 and CBD (Cartiers Beniamino Donzelli) are considered particularly suitable for large-scale use, as they are resistant to disease and grow faster than native species.

Milovanovic, M. 1960. PODACI O USPEVANJU NEKIH ITALIJANSKIH KLONOVA TOPOLA U DONJEM PODUNAVLJU. [DATA ON THE SUCCESS OF SOME ITALIAN CLONES OF POPLAR IN THE LOWER DANUBE REGION.] Topola, Beograd No. 17/18: 8-11. [Serb.f.]

Pokorny, J. 1957. POKUSNA PLOCHA EUROAMERICKYCH TOPOLU NA CERNOKOSTELECKU. [THE CERNOKOSTELEC EXPERIMENTAL AREA OF HYBRID BLACK POPLARS.] Prace Vyzkum. Ust. Lesn. CSR No. 12: 113-27. [Cz.russ.f.]

Saatcioglu, F. 1953. DIE BEDEUTUNG DES PAPPELHOLZES UND UBER ANBAUVERSUCHE MIT RASCHWUCHSIGEN PAPPELBASTARDEN IN DER TURKEI. [THE IMPORTANCE OF POPLAR WOOD AND SILVICULTURAL RESEARCH ON QUICK GROWING POPLAR HYBRIDS IN TURKEY.] Schweiz. Z. Forstw. 104(7/8): 289-96. [G.g.f.]
The importance of poplar for the pulp industry is stressed. Clones imported from Italy (P. euramericana IT 214♀ and 154♂) have been widely used. The pulp industry has now developed a new clone named P. euramericana Turkey Sumer I♂, which is said to give good results. Growth data are given for these three clones.

Spalek, V., and Mottl, J. 1960. SORTIMENT TOPOLU VHODNY PRO VYSADBY V CESKYCH KRAJICH. [VARIETIES OF POPLAR SUITABLE FOR PLANTING IN VARIOUS PARTS OF CZECHOSLOVAKIA.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 6(10): 819-34. 6 refs. [Cz.cz.russ.e.]

232.22

Dobronic, D. 1962. [SOME EXPERIMENTS ON THE REDUCTION IN YIELD OF WHEAT AND MAIZE CAUSED BY THE SHADE OF POPLARS IN POPLAR PLANTATIONS RAISED WITH AGRICULTURAL CROPS.] Topola, Beograd 6(28): 54-6. 2 refs. [Serb.serb.f.f.]
In a 4-year plantation of Populus × marilandica and P. × serotina planted at 3 × 3-5 m. spacing, yields of maize were reduced by 55.9% and wheat by 38.3% vs. those in the open. The author proposes that maize should be grown during the first 3 years, wheat during the next 2, and a mixture of grass and clover during the next 3.

232.315.2

Marjai, Z. 1955. NYARMAGTAROLASI KISERLETEK. [INVESTIGATIONS ON THE STORAGE OF POPLAR SEEDS.] Erdesz. Kutatas., Budapest 1955(4): 111-126. 5 refs. [Hu.russ.e.g.]

———— 1955. EGYES KULSO TENYEZOK HATASA A NYARMAGRA. [THE INFLUENCE OF SOME EXTERNAL FACTORS ON POPLAR SEEDS.] Erdesz. Kutatas., Budapest 1955 (1): 63-81. 10 refs. [Hu.russ. e.g.]

232.318

Jovanovic, B., and Tucovic, A. 1960. ZAPAZANJA O DEJSTVU JONIZUJUCEG ZRACENJA NA SEME NEKIH EURAMERICKIH TOPOLA. PRETHODNO SAOPSTENJE. [THE EFFECT OF IONIZING RADIATION ON THE SEEDS OF SOME EURAMERICAN POPLARS. PRELIMINARY REPORT.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 1: 59-87. 7 refs. [Serb.f.]

232.32

Crvencanin, M. 1960. NEKA ISKUSTVA KOD PODIZANJA RASADNIKA KLONA I-214 U ZLATNOJ GREDI - LOVNO-SUMSKOG GOSPODARSTVA "KOSUTNJAK." [EXPERIENCE GAINED DURING THE ESTABLISHMENT OF A NURSERY OF CLONE I-214 AT ZLATNA GREDA, KOSUTNJAK GAME AND FOREST ESTATE [BILJE, CROATIA].] Topola, Beograd No. 17/18, 4-8. [Serb.f.]
The nursery, on an area of 4.3 ha., contains 200,000 Populus × canadensis cv. 'I-214' plants from imported Italian stock. The first year's work (including site preparation, planting of cuttings, tending, irrigation, protection, etc.) is described, with data on height growth during the first growing season, and general recommendations.

Peschaut, R. 1947. DIE NACHZUCHT DER KANADA- UND ROBUSTA-PAPPEL IM PFLANZGARTEN. [NURSERY PRACTICE FOR "CANADIAN" AND ROBUSTA POPLARS.] Allg. Forst- u. Holzw. Ztg. 58(11/12): 92-4. [G.]

Radulescu, A. V. 1948. CERCETARI PRIVIND DISTANTELE DE SADIRE IN PEPINIERA A BUTASILOR DE PLOPI DE CANADA. [STUDIES IN THE SPACING OF CANADIAN POPLAR CUTTINGS IN NURSERIES.] Rev. Padurilor 63(1): 1-4. [Rum.f.]

232.323.2

Partos, G. 1955. FEHER- ES SZURKENYAR-CSEMETEK MAGROL NEVELESE [RAISING WHITE AND GREY POPLAR SEEDLINGS.] Erdesz. Kutatas., Budapest 1955(2): 155-63. [Hu.russ.e.g.]
To allow for culling, 0.5-0.7 g. (1.0-1.5 c.c.)/sq.m. should be sown, to yield 30 seedlings with a collar diameter of 4 mm. Natural suppression of the rest occurs early. If density is ⊧ 70/sq.m., artificial thinning (to 20-25 stems/sq.m.) appears necessary only if particularly strong plants are required; it should be done when dominants are 25-35 cm. high.

232.324.1

Vidali, E. [1962.] [MECHANICAL EQUIPMENT USED IN POPLAR NURSERIES AND PLANTATIONS.] Proc., 5th World For. Congr., Seattle 1960 Vol. 1 (Sect. 1): 630-4. [F.e.span.]
Briefly describes the Lamatalpa and Populus lifting ploughs. With the latter a tractor driver and one worker lifted 1,000 two-year-old poplars near Casale Monferrato in 40 minutes. Some performance data are also given for the small Kiekens Dekker 508 D and the K.D. Goliath tractor-drawn sprayers, which respectively treated 1- and 2-year poplars at 1½ hr./ha. and mature poplars spaced 6 × 6 m. at ca. 1 hr./ha.

232.328

Anic, M. 1948. O UZGOZJN SADNICA KANEDSKE TOPOLE IZ REZNICA. [PROPAGATING HYBRID BLACK POPLARS FROM CUTTINGS.] Glasn. Sumske Pokuse 9: 121-56. 23 refs. [Croat.e.]

Frohlich, H. J. 1957. DIE VEGETATIVE VERMEHRUNG VON ASPE UND GRAUPAPPEL UND IHRE BEDEUTUNG FUR DEN WALDBAU. [VEGE-

TATIVE PROPAGATION OF ASPEN AND GREY POPLAR AND ITS IMPORTANCE FOR SILVICULTURE.] Allg. Forstzeitschr. 12(14/15): 197-8. 3 refs. [G.]

Jenko, V. 1958. VEGETATIVNO RAZMOZEVANJE SIVEGA TOPOLA. [VEGETATIVE PROPAGATION OF POPULUS CANESCENS.] Gozd. Vestn. 16(2/3): 51-6. 5 refs. [Sloven.]
A short, illustrated, general account, based mainly on German literature.

——— 1958. VEGETATIVNO RAZMNAZANJE SIVE TOPOLE. [VEGETATIVE PROPAGATION OF POPULUS CANESCENS.] Topola, Beograd No. 5: 357-61. 2 refs. [Serb.f.]
Describes two methods, (a) taking root cuttings from the rootstock of felled trees, (b) stimulating shoot development from annual buds by layering 1-year-old coppice shoots from an old rootstock.

232.328.1

Biolcev, A. 1956. KACESTVA NA LETORASTITE ZA REZNICI OT KANADSKA I PIRAMIDALNA TOPOLA V ZAVISIMOST OT GASTOTATA NA PANCETATA-MAJKI. [THE QUALITY OF SHOOTS FOR CUTTINGS OF POPULUS × 'CANADENSIS' AND P. NIGRA VAR. ITALICA IN RELATION TO THE SPACING OF THE PARENT STOOLS.] Nauc. Trud. Lesoteh. Inst., Sofia No. 4: 87-99. 4 refs. [Bulg.russ.]
The optimum stool spacing, for producing shoots 15-18 cm. long and 7-10 mm. thick, was 60-70 cm. for P. canadensis, and 50 cm. for P. nigra var. italica.

Bokor, R. 1954. ADATOK A FEHER ES SZURKENYAR VEGETATIV SZAPORITASANAK KERDESEHEZ. [CONTRIBUTIONS TO THE PROBLEM OF THE VEGETATIVE PROPAGATION OF POPULUS ALBA AND P. CANESCENS.] Erdesz. Kutatas., Budapest 1954(1): 18-25. [Hu.?]
From abstr. in Hung. Agric. Rev. 3(3): 8. 1954. [E.]

Chardenon, J., and Taris, B. 1963. [EFFECTS OF GIBBERELLIC ACID ON POPLAR CUTTINGS.] C. R. Acad. Agric. France 49(12): 1070-7. 5 refs. [F.]

Chiang, W. -J. 1963. [ON GROWING POPULUS "CANADENSIS" BY CUTTINGS.] Sci. Silvae, Peking 8(2): 175-9. [Chin.]

Gunther, H. 1959. DIE ABHANGIGKEIT DES STECKLINGERTRAGES VON DER VERBANDSWEITE, DER LANGE DER AUSGANGSSTECKLINGE UND DER RUTENZAHL AM WURZELSTOCK BEI DER ANLAGE VON PAPPELMUTTERQUARTIEREN. [THE INFLUENCE OF SPACING, LENGTH OF ORIGINAL CUTTINGS AND THE NUMBER OF SHOOTS PER STOOL ON THE YIELD OF CUTTINGS IN POPLAR STOOL-BEDS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 40 (Beitr. Pappelforsch. III): 7-80. 11 refs. [G.g.e.russ.]

Harmath, B. 1961. UZEMI NYARDUGVANYOZASI KISERLETEK TAG HALOZATBAN. [NURSERY SPACING TRIALS WITH POPLAR CUTTINGS.] Erdo 10(10): 452-6. 6 refs. [Hu.hu.russ.g.]

Heitmuller, H. -H. 1954. VEGETATIVE VERMEHRUNG UNTER VERWENDUNG VON WUCHSATOFFEN BEI POPULUS CANESCENS SMITH UND POPULUS TREMULA L. [VEGETATIVE PROPAGATION OF P. CANESCENS AND P. TREMULA WITH THE AID OF GROWTH REGULATORS.] Abstr. in Z. Forstgenet. 3(6): 135-6. [G.]

Izuka, T. 1956. [THE RESPONSE OF CUTTINGS, MORE PARTICULARLY THEIR ROOTING, TO THE METHOD OF GROWTH-REGULATOR APPLICATION.] Trans. 66th Mtg. Jap. For. Soc., pp. 88-9. [Jap.]

[Jugoslavia.] 1950. O USGOJU KANADSKO TOPOLE IZ REZNICA. (NEKOLIKO PRETHODNIH ZAPAZANJA PRAKTICARA.) [REARING "CANADIAN" POPLAR FROM CUTTINGS. (SOME PRELIMINARY OBSERVATIONS OF A PRACTICAL FORESTER.)] Sum. List 74(12): 505-8. [Croat.]

Podhorski, I. 1951. VEGETATIVNO RAZMNAZANJE TOPOLA SPOJENIM RESNICAMA I SVINUTIM PRUTOVIMA. [THE VEGETATIVE PROPAGATION OF POPLAR BY (1) NOTCHGRAFTED [STEM] CUTTINGS AND (2)BENT SHOOT-CUTTINGS.] Sum. List 75(3/4): 157-64. [Croat.e.]

Rubtov, S., and Bindiu, C. 1956. NOI PERSPECTIVE IN INMULTIREA VEGETATIVA A PLOPILOR NEGRI HIBRIZI IN PEPINIERA. [A NEW METHOD FOR VEGETATIVE PROPAGATION OF HYBRID BLACK POPLARS IN THE NURSERY.] Bul. Sti. Acad. Repub. Rom. (Sect. Biol.) 8(2): 381-405. 5 refs. [Rum.rum.russ.f.f.]
The use of very short (6- to 8-cm.) cuttings, planted horizontally, gave very good results. The process of callus- and root-formation are described in detail with numerous drawings. Treatment of cuttings with an emulsion of honey increased the take from 25 to 72.5%; treatment with a heteroauxin was less successful. Plants obtained in this way from short cuttings closely resembled seedlings.

Zabielski, S. 1960. WPLYW WILGOTNOSCI ZRZEZOW TOPOLOWYCH NA PROCENT ICH PRZYJECIA. [THE INFLUENCE OF THE MOISTURE CONTENT OF POPLAR CUTTINGS ON THE PERCENTAGE TAKE.] Las Polski 34(9): 6-7. [Pol.]
Cuttings of Populus × robusta and P. × regenerata gave best survival percent when soaked for 48 hours before planting; soaking for 24 hours also gave much better results than no soaking at all. Thick cuttings (9-12 mm. diam.) gave better survival than thin (7-9 mm.) ones.

Zufa, L. 1962. [SILVICULTURAL, BIOLOGICAL AND ECONOMIC ASPECTS OF THE RAISING OF POPLAR PLANTS HAVING 2-YEAR SHOOTS ON 3-YEAR OR 2-YEAR ROOTS.] Topola, Beograd 6(25/26): 2-7. 2 refs. [Serb.f.]
Concludes, on a basis of a detailed analysis of quality and costs, that young stock provides better material for vegetative propagation than old stools, and that nursery production of plants having a 2-year shoot on 3-year roots (grown for 2 years in a transplant bed from 1-year-old stumped rooted cuttings) is qualitatively and economically superior to that of plants having a 2-year shoot on 2-year roots (produced without transplanting). [*Cf. Sekawin, 1953, Populus sp., 232.328.1.*]

232.328.1/2

Mutibaric, J. 1961. UTICAJ TOPOFIZISA NA GAJENJE TOPOLOVIH SADNICA. [INFLUENCE OF TOPOPHYSIS ON THE RAISING OF POPLAR PLANTS.] Topola, Beograd 5(22/23): 15-6. 2 refs. [Serb.serb.f.]

232.328.2/3

Schrock, O. 1958. DIE GRAUPAPPEL UND IHRE VEGETATIVE VERMEHRUNG. [POPULUS CANESCENS AND ITS VEGETATIVE PROPAGATION.] Zuchter 28(2): 71-80. 15 refs. [G.g.]

Seitz, F. W. 1960. DIE VERMEHRUNG DER GRAUPAPPEL. [PROPAGATION OF POPULUS CANESCENS.] Holzzucht, Reinbek 14(3/4): 19. [G.]

232.328.4

Partos, G. 1956. A FEHER ES A SZURKENYAR VEGETATIV SZAPORITASA. [THE VEGETATIVE PROPAGATION OF WHITE AND GREY POPLARS.] Erdesz. Kutatas., Budapest 1956(4): 167-73. 4 refs. [Hu.russ.e.g.]

232.4

Jobling, J. 1960. ESTABLISHMENT METHODS FOR POPLARS. For. Rec. For. Comm., Lond. No. 43, 16 pp.

232.411

Jobling, J. 1953. ESTABLISHMENT OF POPLARS. Rep. For. Res. For. Comm., Lond. 1951/52: 72-5.

Meiden, H. A. van der, and Overbeek, J. L. F. 1960. MOGELIJKHEDEN IN DE KEUS VAN POPULIERPLANTSOEN. [CHOICE OF PLANTING MATERIAL OF POPLAR.] Ned. Boschb.-Tijdschr. 32(5/6): 184-207. 6 refs. [Du.du.e.e.]
Reprinted as Korte Meded. Bosbouwproefsta., Wageningen No. 42. 1960.

——— and Overbeek, J. L. F. 1960. POSSIBILITIES IN THE CHOICE OF POPLAR PLANTING MATERIAL. Transl. For. Comm., Lond. No. 116, 20 pp. 1961. 6 refs.
Transl. by A. Woods from Ned. Boschb.-Tijdschr. 32(5/6): 184-203. Not for publication.

Olbrich, A. 1950. DIE PAPPELSTUMMELPFLANZUNG. [PLANTING OF POPLARS AS CUT-BACK STOCK.] Holzzucht, Reinbek 10: 77. [G.]
Suggests the use of 1-year-old stock raised from cuttings spaced 25 × 15 cm. in the nursery and cut back to the lowest bud on lifting (shoots to be used again as cutting material). Such plants would usually not need root pruning and the planting hole could be 40 × 40 × 30 cm. This might reduce costs to 1/5 of those for the usually 2-year plants raised at a spacing of 25 × 70 cm. and planted in a hole 50 × 50 × 40 cm.

232.42

Aird, P. L. 1956. FERTILIZERS IN FORESTRY AND THEIR USE IN HARDWOOD PLANTATION ESTABLISHMENT. Pulp Paper Mag. Can. 57(3): 376-384. 10 refs. (Woodl. Sect. Index Canad. Pulp Paper Ass. No. 1542.)

Jobling, J. 1961. RECENT DEVELOPMENTS IN POPLAR PLANTING. Quart. J. For. 55(4): 287-92. 2 refs.
Briefly reviews Forestry Commission experiments which indicate that hybrid black poplars planted in holes made by explosive cartridges grow more vigorously (for the first 4 years at least) than those in normal hand-dug pits. Also discusses the use of very deep or very large planting pits and of post-hole borers in Italy.

232.421

Grut, M. 1962. DEEP-PLANTING OF POPLARS. J. S. Afr. For. Ass. No. 40: 19-22.
Describes the Italian method of planting poplar cuttings in holes made to reach groundwater level [cf. May, below].

May, S. 1959. LA TENUTA AGRARIA NOBILI-NICHETTI CULLA DI UN ORIGINALE SISTEMA DI COLTIVAZIONE DEL PIOPPO. [THE NOBILI-NICHETTI ESTATE, CRADLE OF AN ORIGINAL SYSTEM OF POPLAR-GROWING.] Cellulosa e Carta 10(9): 5-16. 4 refs. [It.g.e.f.]

Mesnil, H. 1960. PLANTATION DE PEUPLIERS A GRANDE PROFONDEUR DANS LES DUNES DU DELTA DU PO. [DEEP PLANTING OF POPLARS IN THE DUNES OF THE PO DELTA.] Rev. For. Franc. 12(3): 166-76. 5 refs. [F.]
Mainly a review of Italian reports [cf. May, above] on the plantations of the Nobili-Nichetti estate, using rooted cuttings and planting holes ca. 4 m. deep. Photographs of excavated root systems are included. [Cf. Costin, 1959, P. lasiocarpa to P. nigra and vars., 232.5.]

232.425

Meiden, H. A. van der. 1961. DIE WIRKUNG DER PHOSPHATDUNGUNG AUF PAPPELPFLANZUNGEN. [THE EFFECT OF PHOSPHATE FERTILIZERS ON POPLAR PLANTATIONS.] Phosphorsaure, Essen 21(1/2): 39-50. 2 refs. [G.]

232.43

Prevosto, M. 1963. [A CONTRIBUTION TO THE ECONOMIC STUDY OF SPACING IN POPLAR PLANTATIONS.] Cellulosa e Carta 14(3): 5-20. [It.e.f.g.]
From a study of several plantations of poplar (clone 'I 214'), it was deduced that m.a.i. of timber from (a) dense stands (1,252 trees/ha.) on a 6-year rotation, was greater than that from (b) a similar stand on a 10-year rotation, and much greater than that from (c) a widely spaced (357 trees/ha.) one on a 10-year rotation; but the mean financial return of (c) was markedly superior to that of (b), and still more superior to that of (a) (Lire 223, 368, L. 165, 190, and L. 107, 818, respectively).

Rojas y Rojas, J. M., and Rojas Valero, E. 1962. EL CHOPO Y LA TECNICA SELVICOLA CLASICA. [POPLAR AND THE CLASSIC METHOD OF GROWING IT.] Montes, Madrid 18(104): 113-6. [Span.]

232.44

Soules, B. 1960. PHTHINOPORINE HE EARINE PHYTEIA TES EURAMERIKANIKES LEUKES. [AUTUMN OR SPRING PLANTING OF [STUMPS OF] EURAMERICAN POPLAR.] Das Chron. 2(20/21): 885-9. [Gk.]
Recent small-scale experiments indicate that autumn planting (November 21) gives more vigorous growth than spring (March 10). Results of 1 year are tabulated.

232.5

Fischer, F. 1960. DIE VERWENDUNG VON SETZSTANGEN BEIM PAPPELANDAU IM APFELSTADT - TAL BEI GOTHA/THURINGEN. [THE USE OF SETTS IN POPLAR PLANTING IN THE APFELSTADT-VALLEY NEAR GOTHA, THURINGIA.] Forst u. Jagd 10(3): 107-8. [G.]

233 AFFORESTATION

Knickmann, E. 1959. ZUR NUTZUNG UNFRUCHTBARER BODEN MIT HOHEM GEHALT AN BLEI UND ZINK. [THE USE OF INFERTILE SOILS WITH HIGH LEAD AND ZINC CONTENTS.] Z. PflErnahr. Dung. 84 (1/3): 255-8. 6 refs. [G.g.e.f.]
The plains north of the Harz Mts. have high contents of Pb and Zn washed down by the rivers. Soils having also a high clay and humus content are suitable for intensive agricultural cropping, but not sandy and gravelly soils. However experimental plantations of hybrid black poplars established on the latter in 1944 have proved successful.

Morgeneyer, W. 1959. DUNGUNGSVERSUCHE AN PAPPELN UNTER VERWENDUNG EINES BRAUNKOHLE-TORF-GEMISCHES. [FERTILIZER TRIALS ON POPLARS WITH A MIXTURE OF LIGNITE AND PEAT.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 40 (Beitr. Pappelforsch. III): 81-133. 6 refs. [G.g.russ.e.]

Nelis, E. 1949. BOISEMENT DES PRAIRIES ET DES TERRAINS HUMIDES. [AFFORESTATION OF MEADOWS AND DAMP SITES.] Bull. Soc. For. Belg. 56(7): 287-92. [F.]

Poljakova, A. I. 1962. [A PROMISING SPECIES OF POPLAR.] Priroda, Moskva 51(8): 119. [Russ.]
A brief note on Populus carrieriana, which shows promise for fixing and afforesting moving sands.

234 FORMATION OF FOREST BY NATURAL SUCCESSION

Babos, I. 1955. A NYARFASOK HOMOKBUCKAN ELOFORDULO MEGJELENESI FORMAI. [FORMS OF JUNIPER/POPLAR STANDS GROWING ON SAND HILLS.] Erdesz. Kutatas., Budapest 1955(4): 31-86. 22 refs. [Hu.russ.e.g.]

235 UNDERPLANTING, ADVANCE PLANTING, ETC. NURSES AND FORMATION OF MIXTURES

Borsos, Z. 1954. ATMENETI TARSULASOK A GYERTYANOS-TOLGYESEK TERMOHELYEN. [TRANSITIONAL ASSOCIATIONS ON HORNBEAM/OAK SITES.] Erdo 3(12): 438-45. [Hu.]

235.41

Red'ko, G. I. 1958. VPLYV CORNOJI VIL'HY (ALNUS GLUTINOSA GAERTN.) NA PRODUKTYVNIST' KANADS'-KOJI TOPOLI (POPULUS CANADENSIS MNCH.). [EFFECTS OF A. GLUTINOSA ON THE YIELD OF P. × CANADENSIS.] Dopovidi Akademiji Nauk Ukrajins'koji RSR 1958(1): 343-6. 1 ref. [Ukr.russ.e.]

235.5

Szodfridt, I. 1963. [STUDIES OF STAND STRUCTURE IN MIXTURES OF POPULUS × ROBUSTA AND P. × MARILANDICA.] Erdo 12(3): 116-24. [Hu.hu.russ.g.]

235.6

Van, L. 1957. A KISKUNHALASI TERMELOHELYFELTARAS GYAKORLATI HASZNOSITASA. [THE PRACTICAL UTILIZATION OF THE SITE SURVEY IN KISKUNHALAS.] Erdo 6(4): 124-7. [Hu.]
From abstr. in Hung. Agric. Rev. 6(4): 7. 1957. [E.] General deep tillage has turned in the grass and weeds for manure, and pit planting of Scots pine and the indigenous Populus canescens among the existing scrub and poplar coppice has been done.

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Peschaut, R. 1947. DIE KULTUR UND PFLEGE DER KANADA- UND ROBUSTAPAPPEL IN DEN DONAUAUEN. [THE CULTIVATION AND TENDING OF "CANADIAN" AND ROBUSTA POPLARS IN THE DANUBE BOTTOMLANDS.] Allg. Forst- u. Holzw. Ztg. 58(17/18): 139-41. [G.]

237.4

Gambi, G. 1955. ESSAIS COMPARATIFS D'ENGRAIS, EN SURFACE ET EN PROFONDEUR, EN POPULICULTURE SPECIALISEE. [COMPARATIVE TRIALS OF FERTILIZERS, APPLIED ON THE SURFACE OR IN HOLES, IN SPECIALIZED POPLAR GROWING.] [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-E, 6 pp. [F.]
Experiments in the application of a complete N.P.K. fertilizer, to 1-year-old plantations of three different clones of Populus 'canadensis', (1) scattered on the surface, in a radius of 50 cm. from each tree, and (2) put in holes at a depth of 20-30 cm., and 40 cm. distant from the tree at a rate in each case of 2 kg./tree, showed no significant difference between the two methods. Fertilizer treatment produced striking increases in diameter and height growth over controls.

———— 1956. CONSIDERAZIONI SULL' IMPIEGO DI METODI STATISTICI NELLA SPERIMENTAZIONE FORESTALE. [THE USE OF STATISTICAL METHOD IN FORESTRY RESEARCH.] Monti e Boschi 7(8): 374-81. [It.f.e.]
After a brief discussion in a general manner, the author illustrates the subject by an account of the use of statistical method in an experimental study of the efficacy of fertilizers, broadcast or dug in, applied to a poplar plantation.

237.41

Liekens, H. 1962. [FERTILIZER TRIALS WITH POPLARS.] Agricultura, Louvain 10(4): 791-826. 23 refs. [Du.du.f.e.]

238 TIMBER PLANTATION CROP REQUIRING SPECIAL TREATMENT

Jobling, J. 1955. FARM AND FOREST: 4. CULTIVATION OF POPLARS. Agriculture (J. Minist. Agric. Lond.) 62(4): 189-90.
Advice on planting sites and suitable soils with special reference to U.K. conditions. Varieties mentioned are Populus eugenei, P. gelrica, P. robusta, P. serotina, and P. serotina erecta.

Pavsa, J. 1959. REZULTATI PLANTAZNOG UZGOJA TOPOLA U SUMARIJI VARAZDIN 1956-1959 G. [RESULTS OF GROWING POPLARS IN PLANTATIONS IN THE VARAZDIN FOREST DISTRICT, 1956-59.] Topola, Beograd 3(10): 811-21. [Serb.f.]

Popnikola, N. 1962. [FIRST RESULTS OF POPLAR PLANTATIONS ON PELAGONIJA AGRICULTURAL ESTATE.] Topola, Beograd 6(25/26): 22-6. 3 refs. [Serb.f.]
Describes planting techniques, spacing, intercropping, etc. Of 5 cultivars, the clone I-214 had best height growth after 2 years.

Simon, M. 1963. [ESTABLISHMENT OF POPLAR PLANTATIONS BY DEEP BORING AND DEEP PLANTING IN THE DUNAARTER STATE FOREST.] Erdo 12(3): 130-8. [Hu.russ.g.]

242 THINNINGS

Hilf, H. H. 1952. KANN MAN PAPPELBESTANDE DURCHFORSTEN? [CAN POPLAR STANDS BE THINNED?] Holz-Zbl. 1952(59). 5 pp. [G.g.]
Hybrid black poplars are physiologically ill adapted to make use of extra growing space provided by thinning. Any thinning will involve loss of increment: early thinning involves little loss but will usually not pay; thinning just before crown closure leaves a long period before the crowns can use the extra growing space; and with late thinning they will never fill the space available. Thus unless prices for pulpwood should ever justify the raising of close, unthinned stands, the initial spacing must be wide enough to eliminate the need for thinning.

25 TREATMENT OF DEFECTIVE DERELICT OR VERY OPEN STANDS

Kovacs, Z. N. 1955. ERDOSITESI, FASITASI IRANYELVEINK A DUNA TISZA-KOZI HOMOKHATAKON. [DIRECTIVES FOR AFFORESTATION AND TREE PLANTING ON SANDY RIDGES IN THE REGION BETWEEN THE DANUBE AND TISZA.] Erdo 4(3): 103-8. [Hu.]

263 IRRIGATED FORESTS

Kohler, J. 1962. [POPLARS AND TREE WILLOWS IN THE ISAR FLOOD-PLAIN.] Dtsch. Landwirtsch. Presse, Hamburg No. 50, 1 p. [G.]
Briefly discusses, on the basis of practical experience, soil requirements, diseases and pests, planting methods, etc., and recommends suitable cultivars.

Krembs. 1956. DIE GRAUPAPPEL IN DEN DONAU-AUEN. [POPULUS CANESCENS IN THE FLOOD-PLAINS OF THE DANUBE.] Allg. Forstzeitschr. 11(27/28): 345-7. [G.]
A lecture describing site conditions, particularly near Ingolstadt, where this poplar, which can be grown on sites unsuitable for black poplars, occurs naturally. Its variability suggests its being a post-glacial hybrid of P. tremula and P. alba. Selection and breeding trials are discussed, including the clone 'Ingol 7,' which can be propagated from cuttings.

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC.; HEDGEROW TREES

Grabhorn, R. 1960. BAUMREIHEN ALS HOCHWASSERSCHUTZ. [TREE ROWS AS PROTECTION AGAINST FLOODS.] Dtsch. Landwirtsch. Presse, Hamburg and Berlin 1960(8): 76. [G.]
(Suppl. to Holzzucht, Reinbek 14(2). 1960)

Moulopoulos, C., and Tsoumis, G. 1959. AUXETIKAI AKANONISTIAI EUROPAMERIKANIKON HUBRIDION LEUKES KALLIERGOUMENON EN MAKEDONIA. [GROWTH ABNORMALITIES IN HYBRID POPLARS CULTIVATED IN MACEDONIA.] Epistemonike Epeteris, Geoponike kai Dasologike Schole, Aristoteleion Panepistemion Thessalonikes, Thessalonike 5: 197-237. 39 refs. [Gk.gk.e.e.]

266 SHELTERBELTS, WINDBREAKS

Baumann, D. O. 1960. WINDSCHUTZ AM SEEDEICH. [WINDBREAKS ON SEA DYKES.] Dtsch. Landwirtsch. Presse, Hamburg 1960(44): 446. [G.]
(Suppl. to Holzzucht, Reinbek 14(5/6), 1960.)

Grohn, W. 1955. SCHWARZKIEFERN UND GRAUPAPPELN ALS WINDSCHUTZPFLANZEN. [PINUS NIGRA AND POPULUS CANESCENS FOR WINDBREAKS.] Holzzucht, Reinbek 9(3/4): 25-6. [G.]
Reports on the successful establishment and growth of P. nigra var. austriaca ball-planted at 80-100 cm. high on poor inland sand-dunes near the southwest coast of Schleswig-Holstein, and suggests using this species (preferably with Syringa vulgaris) and grey poplars in 'Knicks,' the traditional windbreaks of the region.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

352 PERFORMANCE STUDIES IN FELLING AND RELATED OPERATIONS

Giordano, G. 1954. TEMPI E RESA NELL'UTILIZZAZIONE DEL PIOPPO. [TIME AND YIELD STUDIES IN EXPLOITATION OF POPLAR.] Cellulosa e Carta 5(9): 7-15. [It.f.e.]
A study of working times and yield, by assortments, in the exploitation of a 9-year-old stand of hybrid poplar (I 214).

———— 1957[1959]. ETUDE SUR LES TEMPS DE TRAVAIL ET LES PRODUITS OBTENUS DANS L'EXPLOITATION D'UNE PEUPLERAIE DE POPULUS EUROAMERICANA CL. I-214. [TIME AND YIELD STUDY IN EXPLOITATION OF A STAND OF P. 'CANADENSIS' CL. I-214.] Proc., 4th World For. Congr. Dehra Dun 1954, Vol. 2: 511-6. [F.]

4 FOREST INJURIES AND PROTECTION

Goidanich, G., Vivani, W., and Mezzetti, A. 1947. LA "LEBBRA" DEL PIOPPO. [POPLAR "LEPROSY."] Ital. For. Mont. 2(3): 149-55. [It.]

Magyar, P. 1938. THE QUESTION OF CANADIAN POPLAR. Erdesz. Lap. 77(5): 432-45. [Hu.g.f.e.]
Control of red heart.

414.4

Chardenon, J., and Taris, B. 1956. EFFECT PHYTOTOXIQUE DE QUELQUES FONGICIDES VIS-A-VIS DES COUTURES DE PEUPLIERS. [TOXIC EFFECTS OF SOME FUNGICIDES ON POPLAR CUTTINGS.] C. R. Acad. Agric. France 42(14): 709-13. [F.]

416.1

Johannes, H. 1950/51. SEPTOGLOEUM POPULIPERDUM SP. N. ALS ERREGER EINES PAPPELSTERBENS. [S. POPULIPERDUM, CAUSE OF A LETHAL DISEASE OF POPLAR.] Phytopathologische Zeitschrift, Berlin 17(4): 406-10. 4 refs. [G.]
S. populiperdum has been found in Germany on Populus vernirubens, P. bachelierii, P. generosa, and P. robusta.

———— 1951. EIN PAPPELSTERBEN IN NIEDERSACHSEN. [A LETHAL DISEASE OF POPLAR IN LOWER SAXONY.] Mitt. Biol. Zent-Anst., Berlin No. 70: 45-6. [G.]

416.5

Pecrot, A. 1955. DIFFERENTES RELATIONS ENTRE L'APPARITION DE LA GELIVURE CHEZ LE PEUPLIER EURAMERICAIN ET LES PRINCIPAUX CARACTERES MORPHOLOGIQUES DU SOL EN BELGIQUE. [RELATIONS BETWEEN THE OCCURRENCE OF FROST-CRACK IN HYBRID "CANADIAN" POPLARS AND THE PRINCIPAL PHYSICAL CHARACTERS OF THE SOIL.] Spec. Pap. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 67-83. [F.]

422.1

Donaubauer, E. 1963. MELAMPSORA ALLII-POPULINA. [FROST INJURIES AND MELAMPSORA INFECTION ON VARIOUS POPLAR CULTIVARS.] Allg. Forstztg. 74(1/2): Suppl. (Informationsdienst No. 64). 2 pp. 3 refs. [G.]

Poskin, A., and Flon, P. 1955. CONTRIBUTION A L'ETUDE DE LA GELIVURE DES PEUPLIERS EURAMERICAINS EN BELGIQUE. [FROST-CRACK OF "CANADIAN" POPLARS IN BELGIUM.] Spec. Rep. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 3-51. 23 refs. [F.f.]

422.12

Petrescu, L. 1958. VATAMARI CAUZATE DE GER IN ARBORETELE DE PLOPI NEGRI HIBRIZI. [FROST INJURY IN PLANTATIONS OF HYBRID BLACK POPLARS.] Rev. Padurilor 1958(4): 214-5. 3 refs. [Rum.]
Describes injuries caused by the severe frost of 1952 (down to −18° C. in March) in 19-year-old plantations of Populus × euramericana on deep alluvial soils at 80 m. alt. Ca. 30 percent of the trees displayed frost cracks—17 percent typical and 13 percent superficial.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

Bongini, V. 1949. TUMORI DELLA ROBINIA E DEL PIOPPO. [TUMORS OF ROBINIA AND POPLAR.] Ann. Sper. Agr. (n.s.) 3(1): 16-7. [It.]

Ferraris, T. 1936. SPRING WILT OF THE SHOOTS OF CANADIAN POPLAR. Riv. Agric., Roma 32 (736): 223. Rev. Appl. Mycol. 16(1): 5. 1937.

443 FUNGI AND BACTERIA

Anonymous. 1932. DISEASES AND INSECT PESTS OF ELM AND P. CANADENSIS. For. Rundschau 5: 41.

443.2

Muller, R. 1953. ZUR FRAGE DES PAPPELRINDENTODS. [POPLAR BARK DISEASE.] Schweiz. Z. Forstw. 104(9): 408-28. 8 refs. [G.g.f.]

———— 1955. WEITERE ERFAHRUNGEN UBER DEN PAPPELRYNDENTODS (DOTHICHIZA POPULEA). [FURTHER RESEARCH ON POPLAR BARK DISEASE (D. POPULEA).] Schweiz. Z. Forstw. 104(10): 534-5.
Further experiments in the artificial inoculation of poplar seedlings showed that D. populea is unable to infect even sickly plants during the growing season. Infection takes place only when the plants are dormant and the temperature is favorable to fungal development (above 0° C.).

Poleac, E. 1961. USCAREA PUIETILOR DE PLOPI NEGRI HIBRIZI PRODUSA DE CIUPERCILE DOTHICHIZA POPULEA SI CYTOSPORA CHRYSOSPERMA SI COMBATEREA EI. [CANKER OF YOUNG PLANTS OF HYBRID BLACK POPLARS CAUSED BY D. POPULEA AND C. CHRYSOSPERMA, AND ITS CONTROL.] Rev. Padurilor 76(11): 670-3. 8 refs. [Rum.russ. g.f.e.]

443.3

Acatay, A. 1961. [NOTES ON HEARTWOOD DECAY IN POPLAR.] Istanbul Univ. Orm. Fak. Derg. 11B(1): 43-8. 6 refs. [Turk.]
81 sample trees of P. canadensis in three plantations in different districts were cross-cut in 2-m. lengths to ascertain the extent of incipient decay as judged by discoloration; 74 were affected despite growths of 2 to 5 m. in height and 2-5 cm. diam. a year. The decay is ascribed to too high a water table, damage to roots by tractor ploughing, other wounds and insect damage (Saperda carcharias, Trochilium apiforma, Melanophila decastigma) providing ports for decay.

Dahte, A. 1960. VORBEUGUNG GEGEN DOTHICHIZA - BEFALL DER BAUMSCHULPFLANZEN DURCH CHEMIKALIENSPRITZUNG. [PREVENTING DOTHICHIZA ATTACK ON NURSERY PLANTS BY CHEMICAL SPRAYS.] Holz-Zbl. 86(67): 934. [G.]

Donaubauer, E. 1957. UBER EINE BLATT- UND ZWEIGKRANKHEIT DER KANADAPPEL. [A LEAF AND SHOOT DISEASE OF HYBRID BLACK POPLARS.] Allg. Forstztg. 68 (23/24): 341. 6 refs. [G.]
Describes the disease caused by Venturia populina and its conidial form Pollaccia elegans, its occurrence in Austria, and possibilities of control. Bordeaux mixture has been tried with varying success.

Fassi, B. 1955. RICERCHE SUL MARCIUME RADICALE DEL PIOPPO IN PIEMONTE. [ROOT ROTS OF POPLAR IN PIEDMONT.] In Studi e Ricerche Sulla Pioppicoltura, Ente Nazionale per la Cellulosa e per la Carta, Rome, pp. 43-96. [It.]
Describes damage caused by, and morphology and life history of, Rosellinia necatrix, Pholiota aegerita, Armillaria mellea, and Vialina radicicola on "Canadian" poplars.

Georgescu, C. C., and Clonaru, A. 1959. APARITIA CANCERULUI BACTERIAN AL PLOPULUI IN R.P.R. [THE OCCURRENCE OF BACTERIAL CANKER IN HYBRID BLACK POPLARS IN RUMANIA.] Rev. Padurilor 74(3): 169-71. 8 refs. [Rum.russ.g.f.e.]

Kispatic, J. 1957. O PROBLEMU UZGOJA TOPOLA SA FITOPATOLOSKOG GLEDISTA. [POPLAR CULTIVATION FROM A PHYTOPATHOLOGICAL VIEWPOINT.] Topola, Beograd 1(2): 109-24. 9 refs. [Serb.f.]
Discusses recent poor results in the cultivation of hybrid black poplars in Yugoslavia, largely as a result of infection by Dothichiza populea. Aspects considered are poplar site requirements, the location of nurseries, seedling quality, and poplar degeneration. The planting of willow is suggested on very moist sites unsuitable for poplar. Some data are also given on the biology of D. populea. [Cf. F.A. 19, No. 3173.]

Knezevic, I. 1959. POKUSAJ MEHANICKOG SUZBIJANJA DOTHICHIZA POPULEA NA EURAMERICKIM TOPOLAMA. [AN ATTEMPT AT MECHANICAL CONTROL OF D. POPULEA ON HYBRID BLACK POPLARS.] Sum. List 83(10/11): 370-1. [Croat.]

Lange, A. de, and Kerling, L. C. P. 1962. APLANOBACTERIUM POPULI, THE CAUSE OF BACTERIAL CANKER OF POPLAR. Tijdschr. PlZiekt. 68(5): 289-91. 4 refs. [E.e.du.]
A bacterium isolated from cankers of Populus candicans was identical with A. populi [cf. F.A. 20, No. 734]. Cuttings of P. candicans inoculated with bacteria through freshly made leaf scars showed typical symptoms of the disease.

Magnani, G. 1963. [TESTS OF THE RESISTANCE OF SOME EURAMERICAN POPLARS TO DOTHICHIZA POPULEA.] Pubbl. Cent. Sper. Agric. For., Roma 6: 155-78. 10 refs. [It.it.e.e.]
Inoculation tests made on four hybrid clones and on Populus alba confirmed that the best protection against the disease in Central Italy is provided by the use of vigorous planting stock, care in planting and irrigation. 'I 154' proved to be moderately resistant, 'I 214' and 'I 455' moderately susceptible, 'I 262' appreciably and P. alba highly susceptible.

Meiden, H. A. van der, and Vloten, H. van. 1958. ROEST EN SCHORSBRAND ALS BEDREIGING VAN DE TEELT VAN POPULIER. [RUST AND BARK NECROSIS AS THREATS TO POPLAR GROWING.] Ned. Boschb. -Tijdschr. 30(9;10): 261-73; 289. [Du.e.g.] (Korte Meded. Bosbouwproefsta., Wageningen No. 37.)

Milatovic, I. 1963. [SPRING DEFOLIATION OF POPLARS DUE TO POLLACCIA ELEGANS.] Sum. List 87(5/6): 187-90. 12 refs. [Serb.e.]
Describes damage in spring 1963 on Populus × 'canadensis' in Yugoslavia, illustrating symptoms.

Moriondo, F. 1954. OSSERVAZIONI SUL CICLO BIOLOGICO DELLA MELAMPSORA SP. DEL PIOPPO IN ITALIA. [OBSERVATION ON THE BIOLOGICAL CYCLE OF A MELAMPSORA SP. ON POPLAR IN ITALY.] Ital. For. Mont. 9(5): 259-64. 16 refs. [It.it.f.]

Peno, M. 1961. PATOLOSKO ODUMIRANJE KORE TOPOLA I VRBA. [PATHOLOGICAL BARK NECROSIS IN POPLAR AND WILLOW.] Topola, Beograd 5(19): 9-10. 1 ref. [Serb.f.]
Gives a more detailed description, following investigations of a bark necrosis, shown to be of bacterial origin, noted on 'Canadian' poplars (P. × marilandica, P. × robusta, clone I-154) and Salix alba. The disease develops only on very wet sites, and is favored by close spacing; these should be avoided when planting susceptible species.

Vivani, W. 1959. NOTE SULLA 'BATTERIOSI DEL PIOPPO'. [NOTES ON 'BACTERIAL' DISEASE OF POPLAR.] Cellulosa e Carta 10(2): 3-15. 8 refs. [It.f.e.g.]

Vlasov, A. A., Krangauz, R. A., and Ljajman, E. E. 1960. PARAZITIZM VOZBUDITELEJ NEGNILEVYH ZABOLEVANIJ STVOLOV DUBA, JASENJA I TOPOLJA. [PARASITISM OF PATHOGENS CAUSING STEM NECROSES AND CANKERS IN OAK, ASH, AND POPLAR.] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 40: 185-205. [Russ.]

Vujic, P. 1962. [THE SUSCEPTIBILITY OF SOME HYBRID BLACK POPLARS TO DOTHICHIZA POPULEA.] Topola, Beograd 6(28): 77-80. 9 refs. [Serb.serb.f.]
In similar conditions of exposure to infection, it was found that the clones 'I-154' and 'I-214' were thrice as resistant to D. populea infection as the clone 'Jacometti' and Populus × robusta, and when infected, their area of necrosed tissue was only one-tenth of the latter two.

444 VIRUS DISEASES

Corte, A. 1960. IL 'MOSAICO' DEL PIOPPO. [POPLAR MOSAIC DISEASE.] Monti e Boschi 11(3): 127-30. [It.f.e.]

Perisic, M. 1951. NOVA VIRUSNA BOLEST NA KANADSKOJ TOPOLI KOD NAS. [A NEW VIRUS DISEASE OF "CANADIAN" POPLAR IN YUGOSLAVIA.] Sumarstvo 4(5): 313. 1 ref. [Serb.f.]

451.2

Magnani, G. 1959. DANNI PRODOTTI DA RODITORI SU PIOPPO E ONTANO. STUDIO SULLE CICATRIZZAZIONE E SUI TESSUTI CICATRIZIALI. [DAMAGE BY RODENTS ON POPLAR AND ALDER. STUDY OF CALLUS FORMATION AND CALLUS TISSUES.] Pubbl. Cent. Sper. Agric. For., Roma 2: 119-35. 3 refs. [It.it.e.e.]

Milovanovic, M. 1956. STETE OD VODENE VOLUHARICE U MLADIM TOPOLOVIM KULTURAMA I MERE ODBRANE. [INJURIES TO YOUNG POPLAR PLANTATIONS BY ARVICOLA TERRESTRIS AND MEASURES OF CONTROL.] Sumarstvo 9(6/7): 390-3. 1 ref. [Serb.]

Petrovic, N., and Vasic, M. 1958. MASOVNA POJAVA POLJSKE VOLUHARICE I NJENO SUZBIJANJE U LOVNO-SUMSKOM GOSPODARSTVU "KOSUTNJAK." [OUTBREAK AND CONTROL OF MICROTUS ARVALIS AT KOSUTNJAK [SERBIA].] Sumarstvo 11(9/12): 663-5. [Serb.]
M. arvalis, causing severe damage to roots of Populus serotina, P. robusta, and P. marilandica as well as to other species in nurseries and young plantations, was controlled by bait containing Zn_3P_2.

453 INSECTS

Androic, M. 1950. TOPOLIN GUBAR (STILPNOTIA SALICIS L.). [THE SATIN MOTH (LEUCOMA SALICIS).] Sum. List 74(12): 484-7. [Croat.]

Erdem, R. 1951. TURKIYEDE YENI BIR KAVAK KULTUR TAHRIPCISI CRYPTORRHYNCHUS LAPATHI L. [C. LAPATHI AS A NEW PEST OF POPLAR [POPULUS 'CANADENSIS'] STANDS IN TURKEY.] Istanbul Univ. Orm. Fak. Derg. 1A(2): 111-4. [Turk.g.]

Moore, G. 1958. OBSERVACIONES SOBRE ATAQUES DEL ESCARABAJO NEGRO DEL TRIGO (DYSCINETUS GAGATES) EN PLANTACIONES FORESTALES. [ATTACK OF THE BLACK WHEAT BEETLE, D. GAGATES, IN FOREST PLANTATIONS.] Rev. For. Argent. 2(3): 90-2. 1 ref. [Span.]

Pasek, V. 1954. PTEROCOMMA TREMULAE CB. 1940, NOVY SKODCA KANADSKEHO TOPOL'A. [P. TREMULAE, A NEW PEST OF "CANADIAN" POPLAR.] Prace Vyzkum. Ust. Lesn. CSR No. 5: 151-61. 5 refs. [Slovak.russ.g.]
Describes the gradation of this pest on Populus canadensis Moench = P. deltoides Marsch [sic] near Banska Stiavnica in Slovakia during 1951-53.

Qairi, M. A. H. 1951. A PRELIMINARY STUDY OF THE POPLAR LEAF BEETLE—NODOSTOMA SP. Pakistan J. For. 1(2): 119-21.
Life history, damage, etc. of the most important pest of Populus ciliata and P. nigra on the Murroe hills. It has not yet been identified and is possibly a new species.

Soules, B. 1960. PROSBOLAI EURAMERIKANIKES LAUKES HYPO HEMIPTERON. [HEMIPTERA ATTACKING EURAMERICAN POPLARS.] Das. Chron. 2(26): 1164. [Gk.]
A note on Phloeomyzus passerinii and Lepidosaphes ulmi, both found on poplar near Drama, Macedonia (the former brought on stock imported from Italy) where local damage has resulted; with brief notes on control.

Vujic, P. 1960. O POJAVI TOPOLINOG GUBARA (STILPNOTIA SALICIS L.). [AN OCCURRENCE OF S. SALICIS.] Topola, Beograd No. 16: 20-2. 3 refs. [Serb.f.]

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Plavsic-Kirjakovic, V. 1962. [PHYTOPATHOLOGICAL PHENOMENA ON CLONE I-154.] Topola, Beograd 6(29/30): 40-2. 4 refs. [Serb.f.]

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

Petrescu, L. 1955. FORMA SI VOLUMUL PLOPILOR NEGRI HIBRIZI. [FORM AND VOLUME OF HYBRID BLACK POPLARS.] Rev. Padurilor 70(10): 443-8. 9 refs. [Rum.russ.]
On the basis of measurements of 1,283 trees of Populus regenerata, P. marilandica, and P. serotina, the author constructs a volume table and a table of form factors, and compares these with Rumanian figures for P. alba and P. tremula.

Ratzel, K. 1955 UNTERSUCHUNGEN UBER INHALT UND FORM, SOWIE DIE BEZIEHUNG ZWISCHEN KRONE UND ZUWACHS BEI DER PAPPEL. [VOLUME AND FORM OF POPLARS, AND THE RELATION BETWEEN SIZE OF CROWN AND INCREMENT.] SchrReihe Bad. Forstl. VersAnst. No. 10, 84 pp. 33 refs. [G.g.]

524.12

Csiszar, I. 1955. FATOMEGTABLAK SZERKESZTESE. [[A STEP TOWARDS THE] CONSTRUCTION OF POPLAR VOLUME TABLES.] Erdesz. Kutatas., Budapest 1955(4): 15-29. 8 refs. [Hu.russ.e.g.]

524.13

Petrescu, L. 1956. CONTRIBUTII LA STUDIUL FORMEI PLOPILOR NEGRI HIBRIZI. [CONTRIBUTION TO THE STUDY OF THE FORM OF HYBRID BLACK POPLARS.] Rev. Padurilor 71(6): 382-3. [Rum.]
In pursuance of his studies on the form of "Canadian" poplar, the author presents a table of form quotients.

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Dabrowski, T., and Sikora, B. 1955. PROBA OKRESLENIA WYDAJNOSCI SIEDLISK TOPOLOWYCH W OPARCIU O BONITOWANIE ISTNIEJACYCH DRZEWOSTANOW TOPOLOWYCH. [TENTATIVE DETERMINATION OF THE PRODUCTIVITY OF POPLAR SITES, BASED ON THE SITE-CLASS GRADING OF EXISTING POPLAR STANDS.] Roczn. Nauk. Lesn. No. 13: 29-44. 3 refs. [Pol.pol.russ.e.] (Prace Inst. Bad. Lesn. No. 145.)

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Anonymous. 1927. GROWTH FIGURES FOR CANADIAN POPLAR. Silva 15: 46.

Avanzo, E. 1963. [TREE MEASUREMENTS IN A POPLAR PLANTATION AT CASTEL PORZIANO.] Pubbl. Cent. Sper. Agric. For., Roma 6: 251-8. 4 refs. [It.it.e.e.]
Measurements were made on a plantation of Populus × eurameri-

cana, on a sandy soil with high water table, clear felled at 14 years. Initial density had been 433/ha., final density was 389/ha. The stand had never been thinned or pruned and approximated to natural forest. Mean height was 24.2 m., mean b.a. 714 sq. cm., and form factor 0.4.

Georgieff [Georgiev], J. 1959. DIE EUROAMERIKANISCHE PAPPEL, DIE LEISTUNGSFAHIGSTE HOLZART IN DER VOLKSREPUBLIK BULGARIEN. [POPULUS × CANADENSIS, THE TREE WITH THE HIGHEST YIELD IN BULGARIA.] Forst u. Jagd 9(2): 55-7. 6 refs. [G.]
Contains data, from the author's local yield table, on height and diameter growth, and the effect of spacing on diameter, increment, and yield.

Gross. 1932. NEW INFORMATION ON GROWTH ETC. OF P. CANADENSIS. Dtsch. Forstztg. 47: 665.

Petrescu, L., and Disescu, R. 1955. STUDIU PRELIMINAR ASUPRA PRODUCTIEI SI PRODUCTIVITATII ARBORETELOR DE PLOPI NEGRI HIBRIZI. [PRELIMINARY STUDIES ON THE YIELD AND PRODUCTIVITY OF HYBRID BLACK POPLAR STANDS.] Rev. Padurilor 70(7): 315-20. 7 refs. [Rum.]
Gives tabulated data, by age classes (3-32) for poplar (P. regenerata, P. robusta, P. marilandica, and P. serotina) stands in the flood-plain of the lower Danube. Data include mean d.b.h., mean height, number of trees/ha., volume/ha., and m.a.i. in cu.m./ha. as well as minimum and maximum d.b.h., all derived from 56 sample plots.

561 INCREMENT IN HEIGHT, DIAMETER, BASAL AREA, FORM AND QUALITY

Patrone, G. 1950. RICERCHE DENDROMETRICHE SUL PIOPPO DEL CANADA CRESCIUTO A FILARI. [A MENSURATIONAL STUDY OF "CANADIAN" POPLAR GROWN IN ROWS.] Ital. For. Mont. 5(3): 121. [It.]

566 YIELD TABLES AND THEIR CONSTRUCTION

Crocoll, A. 1957. DER MASSENERTRAG VON PAPPELBESTANDEN IN DER NORDBADISCHEN RHEINEBENE. [THE YIELD OF POPLAR STANDS IN THE RHINE PLAIN IN N. BADEN.] Forstwiss. Forsch. No. 8, 36 pp. 2 refs. [G.]

Rohmeder, E. 1943. WUCHSLEISTUNGEN MANNLICHER UND WEIBLICHER KANADISCHER PAPPELN IM GRAFLICH VON PREYSINGSCHEN FORSTBEZIRK MOOS. [YIELD OF MALE AND FEMALE CANADIAN POPLARS IN THE GRAFLICH VON PREYSINGSCHE FOREST DISTRICT MOOS.] Forstwiss. Cbl. u. Thar. Forstl. Jb. No. 6: 225-33. Bblg. [G.g.]

Schmitz-Lenders, B. 1948. PAPPEL-ERTRAGSTAFELN, MIT EINER PAPPEL-MASSENTAFEL IM ANHANG. [YIELD TABLES FOR POPLAR (POPULUS REGENERATA), TO WHICH IS APPENDED A VOLUME TABLE.] M. & H. Schaper, Hannover-Waldhaus. 29 pp. [G.]
Includes volume and money yield tables for single trees, forest stands (7×7, 10×10 m. spacing) and stands on meadowland (20×20 m. spacing).

Walther. 1895. GROWTH AND YIELD OF CANADIAN POPLAR IN HESSEN, GERMANY. Allg. Forst- u. Jagdztg. 71: 343-5.

8 FOREST PRODUCTS AND THEIR UTILIZATION

Paraschiv, E., and Marinescu, D. 1962. UTILIZAREA LEMNULUI DE PLOPI NEGRI HIBRIZI IN INDUSTRIA DE PLACAJE SI PANELE. [THE USE OF THE WOOD OF HYBRID BLACK POPLARS IN THE PLYWOOD AND FIBREBOARD INDUSTRIES.] Industr. Lemn. 13(3): 86-90. 10 refs. [Rum.russ.g.f.e.]
Experiments with Rumanian plantation-grown Populus × regenerata (2 types) and P. × marilandica indicated that the "Celei" type of P. × regenerata (with straight cylindrical stems and thin bark) is suitable for both purposes.

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Lenz, O. 1954. LE BOIS DE QUELQUES PEUPLIERS DE CULTURE EN SUISSE. [THE WOOD OF SOME POPLARS GROWN IN SWITZERLAND.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 30: 1-61. 86 refs. [F.f.g.]

Piccarolo, G. 1958. PROVE TECNOLOGICHE PER ALCUNI CLONI DI PIOPPO. [TECHNOLOGICAL TESTS ON SOME POPLAR CLONES.] Cellulosa e Carta 9(11; 12): 9-22; 15-27. [It.f.e.g.]
The test data include lignin chemistry, wood anatomy (with photomicrographs), stem form, bark percent, physical and mechanical properties, working properties, and pulping properties, and the clones dealt with are Populus × euramericana (Dode) Guinier I-37, I-154, I-214, I-455, I-476, and I-488, and P. × euramericana "f. monilifera."

810 GENERAL INFORMATION ON WOODS

Hartig. 1893. THE GROWTH AND WOOD OF THE CANADIAN POPLAR. Forstl. Naturw. Z. 2: 89-93.

Pallay, N. 1938. INFORMATORY RESEARCH ON THE TECHNICAL QUALITIES OF POPULUS CANADENSIS AND P. ROBUSTA. Erdesz. Lap. 77(10): 850-61. [Hu.g.f.e.]

———— 1938. RESEARCH ON THE TECHNICAL QUALITIES OF POPULUS CANADENSIS AND P. ROBUSTA (CONCLD.). Erdesz. Lap. 77(11): 962-974.

811 STRUCTURE. IDENTIFICATION

Walek-Czernecka, A. 1952. ANATOMIA POROWNAWCZA DREWNA POPULUS ALBA L., POPULUS TREMULA L., POPULUS CANESCENS SM. [COMPARATIVE WOOD ANATOMY OF P. ALBA, P. TREMULA, AND P. CANESCENS.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 8: 1-31. 21 refs. [Pol.russ.f.]

811.14/16

Scaramuzzi, G. 1956. VARIATION OF THE VOLUME PROPORTIONS OF WOOD ELEMENTS WITHIN THE STEM IN POPULUS × EURAMERICANA (DODE) GUINIER CV. "I 214." [Docum.] 12th Congr. Int. Union For. Res. Organ., Oxford 1956 No. IUFRO 56/41/5 Rev. 7 pp. [E.e.]
Investigation on a 10-year-old tree showed little variation in the volume percent of fibres, vessels and rays, within the growth ring either radially or longitudinally or radially across the stem. [Cf. Scaramuzzi, 1955, P. canadensis to P. davidiana, 811.156.]

811.155

Messeri, A. 1954. CARATTERI DIMENSIONALI E STRUTTURALI DELLE FIBRE DI TENSIONE DI UN CAMPIONE DI PIOPPO (POPULUS EURAMERICANA GUINIER, CV. CLONE 214). [DIMENSIONS AND STRUCTURES OF FIBRES IN TENSION WOOD FROM A SAMPLE OF P. "EURAMERICANA" CLONE 214.] Cellulosa e Carta 5(8): 8-10. 6 refs. [It.]

811.156

Scaramuzzi, G. 1955. DIMENSIONAL DATA ABOUT FIBERS IN POPULUS × EURAMERICANA (DODE) GUINIER CV. 'I-214.' [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-C, 20 pp. [E.]

811.22

Vandevelde, R. 1957. BIJDRAGE TOT DE STUDIE VAN REACTIEHOUT. [CONTRIBUTION TO THE STUDY OF REACTION WOOD.] Meded. Lab. Houttechnol., Gent No. 14, 18 pp. 41 refs. [Du.f.e.g.]

812 PHYSICAL AND MECHANICAL PROPERTIES

Curro, P. 1959(1960). INDAGINI TECNOLOGICHE SUL LEGNO DI ALCUNI IBRIDI EURAMERICANI DI PIOPPO. I. CARATTERISTICHE FISICHE E MECCANICHE. [TECHNOLOGICAL INVESTIGATIONS ON THE WOOD OF SOME HYBRID POPLARS [POPULUS × 'CANADENSIS']. I. PHYSICAL AND MECHANICAL CHARACTERS.] Pubbl. Cent. Sper. Agric. For., Roma No. 3: 3-59. 7 refs. [It.it.e.e.]

812.21

Curro, P. 1955. VARIATIONS IN MOISTURE CONTENT, BASIC DENSITY AND OVENDRY DENSITY IN POPULUS × EURAMERICANA (DODE) GUINIER CV. "I-214." [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/79-D, 5 pp. [E.]

———— 1957. PHYSICAL CHARACTERISTICS OF THE WOOD OF POPULUS × EURAMERICANA (DODE) GUINIER 'I 154' AND OF POPULUS TREMULA L. [Docum.] Int. Poplar Comm., 5th Sess. Wkg. Party on Exploitation and Utilization, Paris 1957 No. FAO/CIP/UT-2, 12 pp. 2 refs. [E.]

812.31

Gohre, K. 1960. DIE VERTEILUNG VON ROHWICHTE IM PAPPELSTAMM. [THE DISTRIBUTION OF DENSITY IN POPLAR STEMS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 44 (Beitr. Pappelforsch. No. 4): 51-79. 13 refs. [G.g.russ.e.]

812.7

Hirai, S., Tsuchiya, K., and Aida, T. 1962. [MECHANICAL PROPERTIES OF THE WOODS OF POPULUS SPP. OF THE TOKYO UNIVERSITY FOREST IN HOKKAIDO.] Misc. Inform. Tokyo Univ. For. No. 14: 63-71. 16 refs. [Jap.]
Presents tabulated results of standard tests on P. tremula var. davidiana (separately for green-, orange-, and grey-barked forms) and P. maximowiczii, from trees 28-40 years old; also for 22 Japanese, Manchurian, or Korean provenances of P. maximowiczii.

812.74

Giordano, G., and Curro, P. 1959. LA VARIATION DE LA RESISTANCE AU CISAILLEMENT EN FONCTION DE LA TEMPERATURE. [THE EFFECT OF TEMPERATURE ON SHEAR STRENGTH [OF POPLAR WOOD].] [Docum.] Int. Poplar Comm. 6th Sess. Wkg. Party on Exploitation and Utilization, Rome 1959 No. FAO/CIP/UT-9B, 5 pp. [F.]

813 WOOD CHEMISTRY

Martinez Mata, F. 1960. [FORESTRY GROUP: SECTION FOR FOREST GENETICS.] An. Inst. For. Invest. Exp., Madrid 32(5): 71-7. [Span.]

813.11

Desmet, J. 1960. MISE EN EVIDENCE DE L'HETEROGENEITE D'UNE LIGNINE NATIVE DE POPULUS CANESCENS SM. [HETEROGENEITY OF A NATIVE LIGNIN OF P. CANESCENS.] C.R. Acad. Sci., Paris 250(20): 3374-6. 7 refs. [F.f.]
A study of four fractions obtained from the native lignin indicated that it is not a homogeneous substance.

———— 1960. SEPARATION PAR ELECTROPHORESE DES CONSTITUANTS D'UNE LIGNINE NATIVE DE POPULUS CANESCENS. [ELECTROPHORETIC SEPARATION OF THE CONSTITUENTS OF A NATIVE LIGNIN OF P. CANESCENS.] C. R. Acad. Sci., Paris 251(5): 780-2. 3 refs. [F.f.]
Fourteen fluorescent constituents were obtained, some naturally colored, and also a nonfluorescent, colorless substance giving a positive reaction with phloroglucin/HCl. None of the fractions obtained in the previous study is a pure substance.

Robert, A., and Desmet, J. 1960. ETUDE SPECTROGRAPHIQUE DANS L'INFRAROUGE D'UNE LIGNINE NATIVE DE POPULUS CANESCENS SM. [AN INFRA-RED SPECTROGRAPHIC STUDY OF A NATIVE LIGNIN OF P. CANESCENS.] C.R. Acad. Sci., Paris 251(3): 430-2. 2 refs. [F.f.]
The study showed similar but not identical curves for the native lignin and four fractions from it. It is concluded that the native lignin is a mixture of substances very closely related chemically.

832.15

Senyszyn, P. 1962. [YIELD OF SAWN TIMBER FROM POPLAR THINNINGS.] Silvicultura, Uruguay No. 18: 38-47. [Span.e.f.]
Presents the results of a mill study to estimate yield of sawn timber from small-size Populus × 'canadensis' cv. I-154 (diam. 9-17.8 cm.). Yield was <50%, but costs were low enough to justify the utilization of thinnings of this kind, given reasonably straight stems.

832.2

Istrate, V. 1963. [MANUFACTURING VENEER FROM THE WOOD OF "EURAMERICAN" POPLARS.] Industr. Lemn. 14(5): 165-75. [Rum. russ.g.f.e.]
Gives the results of experiments in rotary cutting of veneer from Rumanian-grown Populus × marilandica and P. × robusta, and discusses the effects of log storage, peeling parameters, and drying of veneers.

847.1

Curro, P. 1962. [SEASONING POPLAR BOARDS.] Cellulosa e Carta 13(11): 21-3. [It.f.e.g.]
Gives tabulated and graphic data showing the changes in m.c. in Populus × euramericana cv. 'I-455' boards 35 mm. thick, stacked (3 × 3 ×3 m.) in the open with stickers and a roof, over a period of 44 weeks at Casale Monferrato. M.c. fell from ca. 191% in November to 23% in the following September.

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Brecht, W. 1953. DIE HERSTELLUNG VON WEISSSCHLIFF AUS PAPPELHOLZ IM SCHLEIFEREI-LABORATORIUM. [MANUFACTURE OF WHITE GROUNDWOOD FROM POPLAR IN A GROUNDWOOD LABORATORY.] Holz Roh- u. Werkstoff 11(8): 293-6. 4 refs. [G.g.]

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

907.3

Pavari, A., and Gasparini, M. 1943. L'ASIONE DI DIFOSA DEI FRANGIVENTI SULLA COLTURA GRANARIA. [THE PROTECTIVE EFFECT OF WINDBREAKS ON CEREAL CULTIVATION.] Mariano Ricci, Via S. Galle 30, Florence. 34 pp. [It.]

91 LAND USE, LAND-USE POLICY, AFFORESTATION POLICY

Moretti, A. 1950. I TERRENI GOLENALI: NUOVI ORIENTAMENTI PER LA LORO UTILIZZAZIONE. [THE MUD BANKS [OF THE R. PO AND ITS CONFLUENTS]: NEW IDEAS FOR THEIR UTILIZATION.] Ital. Agric. 87(9): 563-8. 6 refs. [It.] [Cf. Bernardini, 1948, P. canadensis to P. davidiana, 2.]

P. DELTOIDES TO P. GENEROSA

0 GENERAL

Applequist, M. B. 1959. A SELECTED BIBLIOGRAPHY ON COTTONWOOD (POPULUS DELTOIDES). LSU For. Notes La. Agric. Exp. Sta. No. 24, 3 pp. 35 refs.
U. S. literature, chiefly from 1940.

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

151 MODE OF LIFE, AUTECOLOGY, HABITS, ADAPTABILITY

Steyskal, G. C. 1949(1951). THE DIPTEROUS FAUNA OF TREE TRUNKS. Pap. Mich. Acad. Sci. 35: 121-34. 33 refs.
Notes on Diptera gathered on or under the bark of trunks of Populus deltoides and Robinia pseudoacacia.

———— 1952(1953). FURTHER NOTES ON DIPTERA OF TREE TRUNKS—WITH DESCRIPTIONS OF TWO NEW SPECIES OF DRAPETIS (DIPTERA EMPIDIDAE) AND AN ABSTRACT OF A FINNISH PAPER ON DIPTERA OF TUOMIKOSKI. Pap. Mich. Acad. Sci. 38: 255-60. 4 refs.
Observations on Populus deltoides and Acer spp. and a list with brief notes of species mentioned in the Finnish paper.

160.2

Jayme, G., and Reh, F. 1944. THE EFFECT OF AGE OF POPLAR-WOOD (POPULUS MONILIFERA) ON ITS CHEMICAL COMPOSITION AND SUITABILITY FOR PULP MANUFACTURE. Cellulosechemie 22: 65-72. Chem. Abstr. 40: 2978-80. 1946.

164.5

Marcet, E. 1961. UBER DIE GEOGRAPHISCHE VARIABILITAT BLATT-MORPHOLOGISCHER MERKMALE BEI POPULUS DELTOIDES BARTR. [GEOGRAPHICAL VARIATION IN LEAF MORPHOLOGICAL CHARACTERS IN P. DELTOIDES.] Silvae Genet. 10(6): 161-72. 21 refs. [G.g.f.e.]

164.6

Nagaraj, M. 1952. FLORAL MORPHOLOGY OF POPULUS DELTOIDEN AND P. TREMULOIDES. Bot. Gaz. 114(2): 222-43. 34 refs.

165.51

Gabriel, W. J. 1956. PRELIMINARY REPORT ON CLONAL DIFFERENCES IN THE WOOD AND PHLOEM OF POPULUS DELTOIDES AND P. TRICHOCARPA. Proc., 3rd Northeast. For. Tree Impr. Conf., Ithaca 1955: 33-4.
Data from individual trees indicated statistically significant differences in fibre length and sp. gr. between clones of the two species studied. Variations were also apparent in the fibre arrangement in the phloem. The material was from trees $\leq$ 5 years. Studies should be made on more mature trees to determine whether these juvenile traits are permanent or temporary.

165.71

Catalan, G. 1963. [CROSSES WITHIN THE SECTION LEUCE AND A NOTABLE HYBRID BETWEEN LEUCE AND AIGEIROS.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63-2b/8, 3 pp. [Span.span.]

Jovanovic, B., and Tucovic, A. 1959. ZAPAZANJA O DEJSTVU JONIZUJUCEG ZRACENJA NA SEME I PRIRAST POPULUS VIRGINIANA FOUG. PRETHODNO SAOPSTENJE. [THE EFFECT OF IONIZING RADIATION ON SEEDS AND [SEEDLING] GROWTH OF P. DELTOIDES [$\times$ P. SEROTINA]. PRELIMINARY REPORT.] Sumarstvo 12(9/10): 451-62. 7 refs. [Serb.f.f.]

[New Zealand: Soil Conserv. Rivers Control Coun.] 1959. POPLAR INVESTIGATIONS. Extr. from Report, Soil Conservation and Rivers Control Council, Wellington 1958/1959: 26-9.

168 HISTOLOGY

Pelet, F., and Hildebrandt, A. C. 1957. GROWTH IN VITRO AT VARIOUS TEMPERATURES AND ACIDITES OF TISSUES ISOLATED FROM GALLS AND NORMAL STEMS OF ELM, GRAPE, POPLAR AND WILLOW. Abstr. in Phytopathology 47(9): 531.
Optima for growth on two synthetic media with growth-promoting supplements are given from tests covering the temperature range from 16° C. by 4° to 36° and the acidity range from pH 3.5 to 8 at 26° C.

176.1

Boom, B. K. 1957. POPULUS CANADENSIS MOENCH VERSUS P. EURAMERICANA GUINIER. Acta Bot. Neerland. 6(1): 54-9. 16 refs. [E.e.]
Upholds the validity of the name P. $\times$ canadensis Moench, rejecting P. $\times$ euramericana Guinier, for the hybrids of P. deltoides $\times$ P. nigra.

Burdon. 1929. A HYBRID POPLAR (P. GENEROSA). L'Alpe 16: 528.

Dallimore. 1930. NOTE ON P. GENEROSA HENRY. Quart. J. For. 24: 118.

[International: FAO/Int. Poplar Comm.] 1959. NOMENCLATURE AND REGISTRATION [OF POPLAR HYBRIDS OF THE SECTION AIGEIROS]. [Docum.] 10th Sess. Int. Poplar Comm. 1959 No. FAO/CIP/97, 5 pp. [E.]
Includes an annexe by J. Pourtet, tracing the history of nomenclature refuting recently advanced arguments in favor of Populus canadensis, and concluding that the correct name for the group should be Populus $\times$ euramericana Guinier [cf. Boom, 1957, above].

Makowiecki, S. 1928. TOPOLA PIRAMIDALNA (POPULUS FASTIGIATA PERS.). Roczn. Polsk. Tow. Dendrol. 2, 66 pp.

Mocine. 1931. NOTE ON COTTONWOODS IN U.S.A. Amer. For. 37: 535.

Rose, J. N. 1913. POPULUS MACDOUGALLII: A NEW TREE FROM THE SOUTHWEST. Smithson. Misc. Collect. 61(12).

Vill. 1931. NOTES ON P. MONILIFERA, ROBUSTA, ETC. Mitt. Hoh. Forst Bayerns 26: 87.

Wiese. 1882. NOTES ON P. DILATA. Allg. Forst- u. Jagdztg. 58: 333-6.

Zaborski. 1930. NOTE ON P. EUPHRATICA IN MOROCCO. Bot. Cur. Lit. 12: 7.

———— 1933. ON P. EUPHRATICA IN MOROCCO. Biol. Abstr. 7: 6801.

181 MODE OF LIFE, AUTECOLOGY, SILVICULTURAL CHARACTERS OF TREES

Anonymous. 1908. COTTONWOOD (P. DELTOIDES). U. S. For. Serv. Silv. Leafl. No. 25.

———— 1941. THE SOUTHERN HARDWOODS—COTTONWOOD (POPULUS DELTOIDES VAR. VIRGINIANA, P. HETEROPHYLLA). Sth. Lumberman 162(2040): 29.

Allegri, E. 1954. A BRIEF NOTE ON POPULUS EUPHRATICA OLIV. IN IRAQ. [Pap.] Near East Poplar Conf. 1954, FAO, Rome No. FAO/NEPC/3 and 3 Add. 1, 6 pp. [E.]
Notes on silvicultural characters with a botanical description.

Joachim, H. F. 1954. BEITRAGE ZUR KENNTNIS VON POPULUS EURAMERICANA FORMA GELRICA HOUTZAGERS. [INFORMATION ON P. EURAMERICANA F. GELRICA.] Arch. Forstw. 3(1/2): 23-36. 9 refs. [G.g.]

Putnam, J. A., and Bull, H. 1931. TREES OF THE MISSISSIPPI DELTA: SOUTHERN COTTONWOOD. U. S. For. Serv. Sth. For. Exp. Sta. Occas. Pap. 27: 84-6.

Rodionenko, G. I. 1945. BIOLOGICHESKIE OSOBENNESTI TURANGI —POPULUS DIVERSIFOLIA SCHRENK. [BIOLOGICAL PECULIARITIES OF THE TURANGA—P. DIVERSIFOLIA.] Sovetsk. Bot. 13(6): 35-40. Bblg. [Russ.]

Williamson, A. W. 1913. COTTONWOOD (P. DELTOIDES) IN THE MISSISSIPPI VALLEY. U. S. Dep. Agric. Bull. No. 24.

181.3

Brendemuehl, R. H. 1958. GROWTH, YIELD AND SITE REQUIREMENTS OF EASTERN COTTONWOOD (POPULUS DELTOIDES). Abstr. of thesis, in Iowa St. Coll. J. Sci. 32(2): 140-1.
Analyzes data as to stand and site characteristics including site index, soil texture, moisture, aeration and nutrient content, pH, etc., collected on 66 plots in pure even-aged stands in the floodplains of W. and S.W. Iowa. Available moisture and N-production capacity of the soil were the most important factors for growth.

181.311

Qadri, S. M. A. 1960. CONSERVATION OF WATER IN THE IRRIGATED PLANTATIONS. Pakistan J. For. 10(2): 115-6.

181.341

Hinson, W. H. 1957. [THE STUDY OF NUTRITION OF FOREST SPECIES.] Rep. For. Res. For. Comm., Lond. 1956/57: 62.

181.4

Lawrence, D. B., and Hulbert, L. 1950. GROWTH STIMULATION OF ADJACENT PLANTS BY LUPINE AND ALDER ON RECENT GLACIER DEPOSITS IN SOUTHEASTERN ALASKA. Abstr. in Bull. Ecol. Soc. Amer. 31(3): 58.

181.521

May, S. 1959. UNA MANIFESTAZIONE DI BISESSUALITA NEL PIOPPO NERO AMERICANO. [A CASE OF BISEXUALITY IN POPULUS DELTOIDES.] Cellulosa e Carta 10(7): 6-8. 1 ref. [It.f.e.g.]
Androgynous inflorescences were observed on a 4-year-old Populus deltoides raised from seed obtained from Alabama. Seed has been collected from the tree and the resulting seedlings are under observation at Casale Monferrato. This is believed to be the first record of bisexuality in a black poplar, and its possible importance for breeding is discussed.

181.525

Hosner, J. F. 1957. EFFECTS OF WATER UPON THE SEED GERMINATION OF BOTTOMLAND TREES. For. Sci. 3(1): 67-70. 6 refs.

———— 1958. THE EFFECTS OF COMPLETE INUNDATION UPON SEEDLINGS OF SIX BOTTOMLAND TREE SPECIES. Ecology 39(2): 371-3. 5 refs.

———— 1959. SURVIVAL, ROOT AND SHOOT GROWTH OF SIX BOTTOMLAND TREE SPECIES FOLLOWING FLOODING. J. For. 57(12): 927-8. 5 refs.

182.3

Nath, Ram. 1923. POPLAR (P. EUPHRATICA) FORESTS OF MUZAFFARGARH, PUNJAB. Indian For. 49: 490.

2 SILVICULTURE

Schiemer, E. L. 1940. THE GROWING OF POPULUS DELTOIDES IN SOUTH AFRICA. J. S. Afr. For. Ass. No. 5: 17-28. Bblg.

231.32/33

Johnson, R. L. 1962. WEED CONTROL AND SITE PREPARATION FOR NATURAL REGENERATION OF COTTONWOOD. Proc., 15th Ann. South. Weed Conf., pp. 181-4.

231.331

Burkhardt, E. C. 1962. REFORESTATION BREAKTHROUGH. GIANT PLOW PRODUCES FIRST COMMERCIAL COTTONWOOD PLANTATION FROM SEED. Sth. Lumberman 204(2544): 39-40. 1 ref.

232/232.1

Lin, C. -W. 1963. [PRELIMINARY STUDY ON THE INTRODUCTION OF POPULUS EUPHRATICA ON SALINE SOIL OF THE COASTAL REGION OF N. CHINA.] Sci. Silvae, Peking 8 (3): 248-55. 5 refs. [Chin.]

232.1

Pratt, E. R. 1950. THE FASTEST GROWING TREE. Quart. J. For. 44(3): 142-4.

232.11

[Bechuanaland.] [?1951.] [POPULUS DELTOIDES PLANTATION IN BECHUANALAND.] Rep. For. Dep. Bechuanaland 1950: 1.

Djekov, S. 1957/1958. POPULUS VIRGINIANA FOUG. VO SKOPJE I NEGOVATA OKOLINA. DENDROLOSKA I DENDROMETRIJSKA KARAKTERISTIKA. [P. VIRGINIANA IN SKOPJE AND ITS VICINITY. DENDROLOGICAL AND MENSURATIONAL NOTES.] God. Zborn. Zemj.- Sum. Fak. Univ. Skopje (Sum.) No. 11: 5-27. 8 refs. [Maced.g.g.]

232.13

Larsen, C. S. 1936. NOTES ON THE REMARKABLE GROWTH OF SOME SPECIMENS OF HENRY'S POPLAR (P. GENEROSA). Dansk Skovforen. Tidsskr. 5: 239-41.

232.21

Jones, E. P. 1959. WET SITE SURVIVAL AND GROWTH. U. S. FOR. SERV. STHEAST. For. Exp. Sta. Res. Note No. 130, 2 pp. 2 refs.

232.3

Engstrom, A. 1948. GROWING COTTONWOOD FROM SEED. J. For. 46(2): 130-2.

232.315.2

Gammage, J. L., and Maisenhelder, L. C. 1960. REFRIGERATION PROLONGS VIABILITY OF COTTONWOOD (POPULUS DELTOIDES?) SEED. U. S. For. Serv. Tree Plant. Notes No. 43: 5-6.
Seed was stored (a) in a refrigerator at 40° F., (b) in nylon mesh bags indoors at ca. 75° and (c) as (b) but hung in the shade of a cottonwood tree. The seed had been collected in July from partially opened catkins. Germination was tested daily for 25 days. Seed in lot (c) deteriorated rapidly, germinating poorly after less than 1 week of storage; (b) maintained viability for ca. 1 week; (a) maintained viability for 3-5 weeks.

McComb, A. L., and Lovestead, H. S. 1954. VIABILITY OF COTTONWOOD (POPULUS DELTOIDES) SEEDS IN RELATION TO STORAGE TEMPERATURES AND HUMIDITIES. U. S. For. Serv. Tree Plant. Notes No. 17: 9-11.
Experiments showed that optimum conditions of storage were a temperature of 10° F. with relative humidity 25%. The data suggest that at low temperatures humidity is a critical factor.

232.318

Jovanovic, B., and Tucovic, A. 1959. ZAPAZANJA O DEJSTVU JONIZUJUCEG ZRACENJA NA SEME I PRIRAST POPULUS VIRGINIANA FOUG. PRETHODNO SAOPSTENJE. [THE EFFECT OF IONIZING RADIATION ON SEEDS AND [SEEDLING] GROWTH OF P. DELTOIDES [× P. SEROTINA]. PRELIMINARY REPORT.] Sumarstvo 12(9/10): 451-62. 7 refs. [Serb.f.f.]

232.323.1

Wycoff, H. B. 1960. COTTONWOOD SEEDING AT THE MASON STATE TREE NURSERY. U. S. For. Serv. Tree Plant. Notes No. 41: 13.
Describes a method of sowing Populus deltoides, by suspending catkins from slatted covers over the seedbeds. Burlap is placed over the covers to confine the cotton, and irrigation does not begin until enough seed had been dispersed over the bed.

232.328.1

Allen, R. A., and McComb, A. L. 1955. UBER FAKTOREN, DIE DIE BEWURZELUNG DER STECKLINGE VON DER POPULUS DELTOIDES BARTR. BEEINFLUSSEN. [FACTORS AFFECTING THE ROOTING OF P. DELTOIDES CUTTINGS.] Zbl. Ges. Forstw. 74(4): 199-220. 88 refs. [G.g.]

Allen, R. M., and McComb, A. L. 1956. ROOTING OF COTTONWOOD CUTTINGS. U. S. For. Serv. Sth. For. Exp. Sta. Occas. Pap. No. 151, 10 pp. 7 refs.
A shortened version of the paper published in Zbl. Ges. Forstw. 74(4): 199-220. 1955.

Briscoe, C. B. 1963. ROOTING CUTTINGS OF COTTONWOOD, WILLOW, AND SYCAMORE. J. For. 61(1): 51-3. 6 refs.
Stem cuttings from young Populus deltoides, Salix nigra, and Platanus occidentalis were collected monthly. All species rooted every month, but March was best and June worst. Basal cuttings rooted better than top cuttings. S. nigra rooted and grew faster than P. deltoides which grew faster than P. occidentalis.

Broekhuizen, J. T. M. 1961. HET STEKKEN VAN ENKELE BOOMSOORTEN ONDER WATERNEVEL. [ROOTING CUTTINGS OF SOME TREE

SPECIES UNDER MIST SPRAY.] Ned. Boschb.-Tijdschr. 33(11): 313-25. 1 ref. [Du.du.e.]

———— 1963. [FURTHER EXPERIENCE OF ROOTING CUTTINGS UNDER MIST SPRAY.] Ned. Boschb.-Tijdschr. 35(11): 435-44. 1 ref. [Du.e.e.]

Cunningham, F. E. 1953. ROOTING ABILITY OF NATIVE COTTONWOODS DEPENDS ON THE CLONE USED. U. S. For. Serv. Ntheast. For. Exp. Sta. Res. Note No. 26, 2 pp. 1 ref.
Rooting percent for cuttings from 30 clones of P. deltoides ranged from averages (of 4 replicates for each clone) of 3 up to 100 percent. Rooting for 30 clones of hybrid poplars ranged from averages of 92 to 100 percent.

[International: FAO/Int. Poplar Comm.] 1959. RAPPORTS D'ACTIVITIES DES COMMISSIONS NATIONALES DU PEUPLIER. REPUBLIQUE ARABE UNIE: REGION SYRIENNE. [REPORTS OF THE ACTIVITIES OF THE NATIONAL POPLAR COMMISSIONS: SYRIA.] [Docum.] 10th Sess. Int. Poplar Comm., 1959 No. FAO/59/7/5626, 8 pp. [F.]
Populus euphratica was successfully propagated from cuttings without special treatment. Some information on pests and on the areas under various poplars is given.

Reinders-Gouwentak, C. A. 1953. VEGETATIVE PROPAGATION OF POPULUS CUTTINGS FROM SOUTH AFRICA IN SPRING IN THE NETHERLANDS. Proc. Ned. Akad. Wet. 56C(1): 66-70. 4 refs. [E.e.]

[U.S.A.: Cent. St. For. Exp. Sta.] 1959. VEGETATIVE PROPAGATION OF POPLARS. Rep. U. S. For. Serv. Cent. St. For. Exp. Sta. 1958: 33-4.

[U.S.A.: Sth. For. Exp. Sta.] 1957. [ROOTING OF COTTONWOOD CUTTINGS.] Rep. U. S. For Serv. Sth. For. Exp. Sta. 1956: 24.
Cuttings from the current-year top of mature trees rooted less well than cuttings from the current-year top of plants recently raised from seed. Only 32% of cuttings taken from previously rooted topwood cuttings struck roots, compared with 55% from stools of more recent seedling origin. Auxin did not improve rooting ability of either type.

232.4

Bull, H., and Muntz, H. H. 1943. PLANTING COTTONWOOD ON BOTTOMLANDS. Bull. Miss. Agric. Exp. Sta. No. 391, 18 pp.

———— and Putnam, J. A. 1941. FIRST-YEAR SURVIVAL AND HEIGHT GROWTH OF COTTONWOOD PLANTATIONS AT STONEVILLE, MISS. U. S. For. Serv. Sth. For. Exp. Sta. Occas. Pap. No. 98, 16 pp.

232.41

Bull, H. 1941. COTTONWOOD WILDINGS MAKE GOOD PLANTING STOCK. U. S. For. Serv. Sth. For. Exp. Sta. Sth. For. Notes No. 37, p. 1.

232.5

Moore, H. 1958. PLANTING COTTONWOOD CUTTINGS. Proc., 7th For. Symp. La. Sch. For., pp. 10-5. 17 refs.
Describes methods used in direct planting of cottonwood [?Populus deltoides] cuttings, with details of costs and returns. Though cuttings can be taken from natural stands, it is more convenient to take them from nursery stock planted 1 ft. apart in rows 40 in. apart.

Nelson, T. C. 1957. SURVIVAL AND EARLY GROWTH OF AN EASTERN COTTONWOOD PLANTATION IN THE PIEDMONT. U. S. For. Serv. Tree Plant. Notes No. 28: 9.
Half an acre of floodland was disc harrowed and planted with unrooted cuttings of Populus deltoides at 9 × 9 ft., with ca. 14 in. underground and ca. 6 in. above. The area was flooded for 3 days after planting, and again for 3 days after leafing had begun. Over 88% rooted and survived the first growing season, and average height growth was 7 ft.

233 AFFORESTATION

Maisenhelder, L. C., and Heavrin, C. A. 1957. SILVICS AND SILVICULTURE OF THE PIONEER HARDWOODS—COTTONWOOD AND WILLOW. Proc. Soc. Amer. For. 1956: 73-5.
Describes the silvicultural characters of Populus deltoides and Salix nigra, which are pioneer species on the "new land" of the Mississippi meanders, and makes recommendations for planting these species on such sites.

Maloney, M. M. 1942. REVEGETATION OF COAL STRIPPED LAND NEAR HENRYETTA, OKLAHOMA. Proc. Okla. Acad. Sci. 22: 123-9.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Maisenhelder, L. C. 1951. PLANTING AND GROWING COTTONWOOD ON BOTTOMLANDS. Bull. Miss. Agric. Exp. Sta. No. 485, 23 pp.
Supersedes an earlier bulletin [Bull and Muntz, 1943, P. deltoides to P. generosa, 232.4], and gives information on nursery practice, planting, tending, protection, and costs of establishing plantations of Populus deltoides on floodlands of the great southern rivers.

———— 1960. COTTONWOOD PLANTATIONS FOR SOUTHERN BOTTOMLANDS. U. S. For. Serv. Sth. For. Exp. Sta. Occas. Pap. No. 179, 24 pp.
The bulletin, summarizing 18 years of research at Stoneville, Mississippi, supersedes an earlier one published in 1951.

May, S. [1960?] CULTURE INTENSIVE DU PEUPLIER DANS UNE PROPRIETE SUR DU TERRAIN DE BONIFICATION A CODIGORO. [INTENSIVE POPLAR CULTIVATION NEAR CODIGORO [FERRARA] ON RECLAIMED LAND.] Istituto di Sperimentazione per la Pioppicoltura, Casale Monferrato, Italy. 16 pp. [F.]

Metreveli, P. A. 1952. KULTURY TOPOLJA KANADSKOGO V KOLHIDE. [PLANTATIONS OF POPULUS DELTOIDES IN COLCHIS (GEORGIA).] Lesn. Hoz. 5(1): 37-8. [Russ.]

242 THINNINGS

Georgopulos, A. 1955. ERSTE ERGEBNISSE EINES DURCHFORSTUNGSVERSUCHES BEI DER PAPPEL. [FIRST RESULTS OF A THINNING STUDY ON POPLAR.] Schweiz. Z. Forstw. 106(5): 273-86. [G.f.]
Sample plots of two very dense stands of poplar (probably P. deltoides var. monilifera) were thinned at about 10 years old and remeasured 2 years later. Mensurational data are given. The residual stands reacted very favorably. Thinnings should be made early and often, the last taking place before the trees have finished their height growth (20-30 years).

Johnson, J. W. 1950. COTTONWOODS RESPOND TO SELECTION CUTS. U. S. For. Serv. Sth. For. Exp. Sta. Sth. For. Notes No. 66, p. 2.

Obye, K. D. 1958. THINNING COTTONWOOD AND WILLOW (SALIX NIGRA). Proc., 7th For. Symp. La. Sch. For., pp. 35-41. 5 refs.
Summarizes several experiments in thinning dense natural stands.

[U.S.A.: Cent. St. For. Exp. Sta.] 1959. EASTERN COTTONWOOD RESPONDS TO THINNING. Rep. U. S. For. Serv. Cent. St. For. Exp. Sta. 1958: 42-3.
An 8-year-old stand of Populus deltoides thinned from 85 sq. ft. b.a. to 50 sq.ft., put on 2.4 in. diam. increment in 5 years (185 trees/acre), vs. 1.7 in. for control (268/acre). Volume increment in cu. ft. was the same in both.

244 CLIMBER CUTTING, ETC.

[U.S.A.: Sth. For. Exp. Sta.] 1961. VINES AND COTTONWOOD GROWTH. Extr. from Rep. U. S. For. Serv. Sth. For. Exp. Sta. 1960. 8-9. 1 ref.

245.1

Johnson, R. L. 1961. PRUNING COTTONWOOD AND WILLOW OAK. U. S. For. Serv. Sth. For. Exp. Sta. Sth. For. Notes No. 136, p. 2.
In willow oak aged 25-30 years, pruned to 17.4 ft., healing was slower than in cottonwood. Cuts from live branches healed faster than those from dead ones; 96 and 98% of wounds had healed after the 4th year. Insect and rot damage were also more prevalent in the oak. Oak developed epicormics to an extent that degraded many butt logs.

245.13

Johnson, R. L. 1959. PRUNING COTTONWOOD. Sth. Lumberman 198(2473): 28-9.
In a 14-year stand spaced 8×8 ft. in Mississippi, 13 trees averaging ca. 9 in. d.b.h. and 50 ft. in height, were pruned to 17.4 ft. Wounds, mostly from live branches less than 2½ in. in diameter, nearly all healed within 2 years. Rot and infection, and growth of epicormics, were slight. Growth was not affected, but in other, younger, stands it was reduced by pruning, suggesting that no more than half the living crown should be removed.

266 SHELTERBELTS, WINDBREAKS

Andreae, E. 1953. LE RIDEAU-ABRI DE L'EPINETTE ET SES PEUPLIERS. [THE EPINETTE SHELTERBELT AND ITS POPLARS.] Foret, Neuchatel 7(2): 22-4. [F.]
Gives data on the volumes of a number of "Carolina" poplars felled at different times in Swiss shelterbelts, particularly in that at Epinette, established in 1912 with plants of unknown origin.

4 FOREST INJURIES AND PROTECTION

441 FOREST WEEDS

Kuntz, J. E., and Riker, A. J. 1950. CHEMICAL CONTROL OF WOOD COMPETITION IN FOREST PLANTATIONS. Abstr. in Res. Rep. 7th Ann. Nth. Cent. Weed Control Conf., pp. 242-3.

443 FUNGI AND BACTERIA

Benben, K. 1954. NOWE CHOROBY TOPOLI. [NEW DISEASES OF POPLARS.] Sylwan 98(2): 91-5. 7 refs. [Pol.]

Nagel, C. M. 1949. LEAF RUST RESISTANCE WITHIN CERTAIN SPECIES AND HYBRIDS OF POPULUS. Abstr. in Phytopathology 39(1): 16.

443.3

Boyer, M. G. 1961. A FUSARIUM CANKER DISEASE OF POPULUS DELTOIDES MARSH. Canad. J. Bot. 39: 1195-204. 20 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 655.)

Butin, H. 1955. UBER DEN EINFLUSS DES WASSERGEHALTES DER PAPPEL AUF IHRE RESISTENZ GEGENUBER CYTOSPORA CHRYSOSPERMA (PERS.) FR. [EFFECT OF THE WATER CONTENT OF POPLAR ON ITS RESISTANCE TO C. CHRYSOSPERMA.] Phytopath. Z. 24(3): 245-64. 18 refs. [G.g.]

———— 1956. UNTERSUCHUNGEN UBER RESISTENZ UND KRANKHEITSANFALLIGKEIT DER PAPPEL GEGENUBER DOTHICHIZA POPULEA (SACC. ET BR.) [STUDIES ON THE RESISTANCE AND SUSCEPTIBILITY OF POPLAR TO D. POPULEA.] Phytopath. Z. 28(4): 353-74. 23 refs. [G.g.]

Moriondo, F. 1958. SU UNA MORIA DI PIOPPI IN VAL DI NIEVOLE. [[FUNGUS] DAMAGE TO POPLARS IN THE VAL DI NIEVOLE.] Ann. Accad. Ital. Sci. For. 7: 189-95. 13 refs. [It.f.]
Describes the damage caused by Stereum purpureum to stands of Populus 'Eucalyptus'.

Ogawa, J. M. 1954. THE OCCURRENCE OF HENDERSONULATORULOIDEA NATTRASS ON POPULUS SPECIES IN CALIFORNIA. U. S. Dep. Agric. Plant Dis. Reptr. 38(3): 238. 3 refs.
H. toruloidea, a major pathogen of Persian walnut and fast becoming a serious menace of citrus and fig in California, was isolated from dead poplar (P. fremontii) and from dead branches on living poplar in Fresno County.

Schmidle, A. 1955. UBER INFEKTIONSVERSUCHE MIT SEPTOTIS POPULIPERDA WATERMAN ET CASH AN POPULUS DELTOIDES. [INOCULATION EXPERIMENTS WITH S. POPULIPERDA ON P. DELTOIDES.] Angew. Bot. 29(1): 14-25. 7 refs. [G.g.]

Wright, E. 1957. CYTOSPORA CANKERS OF COTTONWOOD. U. S. Dep. Agric. Plant Dis. Reptr. 41(10): 892-3.

453 INSECTS

Grobler, J. H. 1958. DAMAGE CAUSED BY GALL APHIS NEGLIGIBLE. Fmg. S. Afr. 34(2): 47-8.

Ignoffo, C. M. 1958. THE LIFE HISTORY AND GALL DEVELOPMENT OF MORDWILKOJA VAGABUNDA WALSH, (HOMOPTERA: APHIDIDAE) ON POPULUS DELTOIDES MARSH. Abstr. of thesis, in Dissert. Abstr. 18(1): 338-9. [Univ. Minn.]

————and Granovsky, A. A. 1961. LIFE HISTORY AND GALL DEVELOPMENT OF MORDWILKOJA VAGABUNDA (HOMOPTERA: APHIDAE) ON POPULUS DELTOIDES. PART I - LIFE HISTORY. PART II - GALL DEVELOPMENT. Ann. Ent. Soc. Amer. 54(4): 486-99; (5): 635-41.
(I) Contains a taxonomic review of the species, descriptions of all known stages, and an account of its life history in the Minneapolis-St. Paul area of Minnesota. (II) Describes gall formation and development in detail.

Kudler, J. 1961. [POSSIBILITIES OF CONTROLLING SAPERDA POPULNEA.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 7(7): 619-34. 30 refs. [Cz.cz.russ.e.]

[U.S.A.: Sth. For. Exp. Sta.] 1958. YOUNG COTTONWOODS DAMAGED BY TWIG BORER. Rep. U. S. For. Serv. Sth. For. Exp. Sta. 1957: 15.
A twig borer, tentatively identified as Gypsonoma sp., probably haimbachiana, severely injured the terminals of young cottonwoods in the Mississippi region, causing stunted bushy growth. The overwintering larvae enter the twigs in early spring. Several generations may develop in 1 year.

[U.S.A.: Sth. For. Exp. Sta.] 1963. [INSECTS AFFECTING COTTONWOOD.] Extr. from Rep. U. S. For. Serv. Sth. For. Exp. Sta. 1962: 41.

Wickman, B. E. 1963. THE LARGE ASPEN TORTRIX, CHORISTONEURA CONFLICTANA, IN CALIFORNIA (LEPIDOPTERA: TORTRICIDAE). J. Econ. Ent. 56(5): 593-6. 4 refs.
Describes with notes on the life-history and parasites of the insect, the first outbreak in the state of this defoliator of Populus tremuloides. First found in California in 1922, it had rarely been collected there, since.

5 FOREST MENSURATION

524.315

Chopra, R. S. 1939. PRELIMINARY VOLUME TABLES FOR BHAN (POPULUS EUPHRATICA OLIV.). Punjab For. Rec. Silva Publ. 1(6). 9 pp.

531 CROWN DIMENSIONS, CROWN AREA, CROWN VOLUME, CROWN RATIO

Berlyn, G. P. 1962. SOME SIZE AND SHAPE RELATIONSHIPS BETWEEN TREE STEMS AND CROWNS. Iowa St. J. Sci. 37(1): 7-15. 11 refs.

54/56

Sipovic, V. V. 1963. [INVESTIGATION OF THE GROWTH OF POPULUS DIVERSIFOLIA STANDS.] Lesn. Z., Archangel'sk 6(2): 27-8. [Russ.]
Presents a table for determining site class by tree height, and yield tables for site classes I, II, and III for ages 15, 16, and 17—30 years, based on measurements on 176 sample plots and 1,120 sample trees in Soviet Central Asia.

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Broadfoot, W. M. 1960. FIELD GUIDE FOR EVALUATING COTTONWOOD SITES. U. S. For. Serv. Sth. For. Exp. Sta. Occas. Pap. No. 178, 6 pp.
Two keys are given: (a) applicable only to sites in the Mississippi floodplain, based on soil texture, drainage, and moisture; and (b) requiring determination of the soil series.

Neebe, D. J., and Boyce, S. G. 1959. SITE INDEX CURVES FOR EASTERN COTTONWOOD (POPULUS DELTOIDES). U. S. For. Serv. Cent. St. For. Exp. Sta., Sta. Note No. 126, 2 pp.
Data were collected from 172 trees, mainly 11-32 years old, in four States. The curves, presented as straight lines, show the heights attained by the trees at 25 years. Average site index was 98 for bottomland, and 78 for upland and spoil-bank areas.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Minckler, L. S., and Lamendola, P. E. 1953. GROWTH OF A WELL-STOCKED COTTONWOOD STAND. U. S. For. Serv. Cent. St. For. Exp. Sta., Sta. Note No. 75, 2 pp.
Gives figures showing changes in the number of live trees and bd.ft. values/acre for different diameter classes between 1949 and 1953.

Pratt, E. R. 1953. POPULUS EUGENEI. Quart. J. For. 47(1): 28-32.
Further data on increment of P. eugenei.

Walker, N. 1957. JUVENILE DEVELOPMENT OF A COTTONWOOD STAND IN CENTRAL OKLAHOMA. J. For. 55(1): 34-5.
In 1946 a 1/8-acre plot was laid out in a naturally established stand of 2- to 3-year cottonwood seedlings. Black willow stems were removed by weeding. Its development over the 10-year period is described and d.b.h., b.a. increment and vol. (in cu.ft.)/acre are tabulated.

6 FOREST MANAGEMENT

Swenning. 1924. COTTONWOOD AND SILVER MAPLE, MANAGEMENT. J. For. 22: 178.

61 FOREST MANAGEMENT: GENERAL, THEORY AND PRINCIPLES

Switzer, H. D. 1948. THE MANAGEMENT OF COTTONWOOD IN THE BOTTOMLANDS OF SOUTHERN ILLINOIS. Sth. Lumberman 177(2225): 153-7. 3 refs.

613 EXPLOITABILITY AND ROTATION

Anonymous. 1926. COTTONWOOD CUT IN 40-YEAR ROTATION. Amer. For. 32: 636.

651.5

Anonymous. 1928. ECONOMIC AGE FOR CUTTING P. EUPHRATICA IN BOMBAY. For. Res. India 1928-29: 51.

———— 1929. ECONOMIC AGE FOR CUTTING BAHAN P. EUPHRATICA. For. Res. India, p. 51.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Klauditz, W. 1951. UBER DIE MECHANISCHEN EIGENSCHAFTEN UND CHEMISCHE ZUSAMMENSETZUNG DES STAMMHOLZES ZWEIER PAPPELHYBRIDEN. [MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION OF THE STEM WOOD OF TWO POPLAR HYBRIDS.] Holz Roh- u. Werkstoff 9(5): 81-4. 11 refs. [G.g.]

810 GENERAL INFORMATION ON WOODS

Anonymous. 1944. FOUR AMERICAN WOODS: FACTS ABOUT WHITE OAK, COTTONWOOD, SHORTLEAF PINE AND SUGAR PINE. Timb. Tr. J. 169(3529): 109-10.

Betts, H. S. 1943. AMERICAN WOODS: COTTONWOOD. U. S. For. Serv. 10 pp. Bblg.

811.156

Boyce, S. G., and Kaeiser, M. 1960. SMALL INCREMENT CORES CAN BE USED FOR SAMPLING COTTONWOOD FIBERS. J. For. 58(6): 484-5. 3 refs.
It was found that mean fibre length in Populus deltoides can be accurately determined from small increment cores (5.2 mm. diameter). Measurements were the same from these small cores as from large cores or wedge-shaped sections. The method is rapid and easy, does little damage to trees, and can be applied to species where the maximum length of the fibre does not exceed 2 mm.

———— and Kaeiser, M. 1961. ENVIRONMENTAL AND GENETIC VARIABILITY IN THE LENGTH OF FIBERS OF EASTERN COTTONWOOD (POPULUS DELTOIDES). Tappi 44(5): 363-6. 15 refs.

Kaeiser, M. 1956. VARIATIONS IN FIBER LENGTH OF EASTERN COTTONWOOD. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 2047, 4 pp. 5 refs.

———— and Stewart, K. D. 1955. FIBER SIZE IN POPULUS DELTOIDES MARSH. IN RELATION TO LEAN OF TRUNK AND POSITION IN TRUNK. Bull. Torrey Bot. Cl. 82(1): 57-61. 7 refs.

[U.S.A.: Cent. St. For. Exp. Sta.] 1959. FIBRE LENGTH OF COTTONWOOD. Rep. U. S. For. Serv. Cent. St. For. Exp. Sta. 1958: 39.
Mean fibre length was found to increase, the faster the height and diameter growth and the older the tree. These influences accounted for 60% of the variability in fibre length among the 83 trees studied, the remaining 40% probably being hereditary.

811.22

Berlyn, G. P. 1959. A BIOMETRIC TECHNIQUE FOR REACTION TISSUE RESEARCH. Proc. Iowa Acad. Sci. 66: 98-102. 4 refs.

Kaeiser, M. 1955. FREQUENCY AND DISTRIBUTION OF GELATINOUS FIBRES IN EASTERN COTTONWOOD. Amer. J. Bot. 42(3): 331-4.

———— and Pillow, M. Y. 1955. TENSION WOOD IN EASTERN COTTONWOOD. U. S. For. Serv. Cent. St. For. Exp. Sta. Tech. Pap. No. 149, 9 pp.

812.31

Peterson, K. R., Guiher, J. K., and Walters, C. S. 1959. THE SPECIFIC GRAVITY OF EASTERN COTTONWOOD [POPULUS DELTOIDES] GROWN IN ILLINOIS. For. Note Ill. Agric. Exp. Sta. No. 86, 2 pp. 1 ref.
The average specific gravity for P. deltoides grown in Illinois was the same as that throughout its natural range.

812.7

Venet, J. 1955. ESSAIS SUR LA RESISTANCE MECANIQUE DU BOIS DE PEUPLIER FAITS AU LABORATOIRE DE TECHNOLOGIE DE L'ECOLE NATIONALE DES EAUX ET FORETS. [TESTS OF THE MECHANICAL STRENGTH OF POPLAR WOOD MADE AT THE ECOLE DES EAUX ET FORETS, NANCY.] Annexe to [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-B: 9-12. [F.]
Gives the results of tests on P. deltoides ("carolinensis"), × P. regenerata, and P. tremula.

813.14

Karacsonyi, S. 1962. [STUDY OF HEMICELLULOSES FROM BROADLEAVED TREES.] Drev. Vyskum 1962(3): 233-49. 25 refs. [Slovak. russ.g.e.]

813.6

Hanson, N. S. 1947(1948). EFFECT OF TREATMENTS WITH AMMONIUM SULPHATE AND SODIUM CHLORATE ON STUMPS OF COTTONWOOD (POPULUS DELTOIDES). Abstr. in Res. Rep. 4th Ann. Nth. Cent. Weed Control Conf., p. 260.

815.5

Baudendistel, M. E., and Akins, V. 1946. HIGH LONGITUDINAL SHRINKAGE AND GELATINOUS FIBERS IN AN ECCENTRIC COTTONWOOD LOG. J. For. 44(12): 1053-7.

Haskell, H. H. 1958. STRENGTH PROPERTIES OF TENSION WOOD AND TYPICAL WOOD IN A LEANING EASTERN COTTONWOOD TREE. For. Prod. J. 8(1): 17-22. 7 refs.

Wahlgren, H. E. 1957. EFFECT OF TENSION WOOD IN A LEANING EASTERN COTTONWOOD. For. Prod. J. 7(6): 214-9. 13 refs.

831.2

Ishaq, S. M. 1960. THE USE OF TIMBER IN COAL MINES. Pakistan J. For. 10(2): 127-32.
An account of the types and dimensions of timber (mainly Acacia arabica and Populus euphratica) used in the coal mines of Baluchistan, consumption, supplies, and the need for plantations to ensure a sufficient supply.

832.3

Pratt, E. R. 1954. ROTARY VENEERS. Quart. J. For. 48(4): 297-9.
Comments on the Report of the Matchwood Working Party, dealing mainly with available supplies of logs suitable for rotary veneer cutting for matchboxes and match stock. The writer questions the statement that it is impossible to grow sufficient quantities in Britain, Populus eugenei is almost as satisfactory as aspen for this purpose, and grows much faster and larger.

834.1

Walters, C. S. 1942. COTTONWOOD SHINGLES FOUND ON ILLINOIS PIONEER'S HOME. J. For. 40(6): 507-8.

847.2

Walters, C. S. 1955. KILN-DRYING GREEN EASTERN COTTONWOOD [POPULUS DELTOIDES]. For. Note Ill. Agric. Exp. Sta. No. 53 (rev.), 2 pp.

852.16

Berlyn, G. P. 1961. FACTORS AFFECTING THE INCIDENCE OF REACTION TISSUE IN POPULUS DELTOIDES BARTR. Iowa St. J. Sci. 35 (3): 367-424. 58 refs.

———— 1961. FACTORS AFFECTING THE INCIDENCE OF REACTION TISSUE IN POPULUS DELTOIDES BARTR. Abstr. of thesis, in Dissert. Abstr. 21(7): 1689-90. [Iowa State Univ. of Sci. and Tech.]

Clark, W. P. 1956. EFFECT OF TENSION WOOD ON SEASONING AND MACHINING OF EASTERN COTTONWOOD. For. Prod. J. 8(3): 109-12. 8 refs.

Lassen, L. E. 1959. TENSION WOOD IN EASTERN COTTONWOOD, ITS EFFECT ON DENSITY, TOUGHNESS, AND COMPRESSION. For. Prod. J. 9(3): 116-20. 12 refs.
Describes tests with matched samples from the upper and lower sides of five Populus deltoides stems having leans of $\geq 10\%$. The upper, tension-wood side was generally heavier, tougher, and slightly more elastic, but weaker in compression. Toughness was apparently more related to position than to specific gravity, being greatest near the bark (i.e., where there was the greatest amount of gelatinous fibres).

McCoy, E. W. 1957. HOW TO MINIMIZE THE EFFECTS OF TENSION WOOD IN COTTONWOOD. U. S. For. Serv. Cent. St. For. Exp. Sta., Sta. Note No. 103, 2 pp. 4 refs.
Recommendations for reducing losses in Populus deltoides caused by tension wood, include: (1) to remove in thinnings all trees with a lean $\geq 4°$; (2) to mark during logging the upper face of trees with such a lean and to discard in the sawmills that portion under the upper face.

852.17

Clark, W. P. 1960. COTTONWOOD TROUBLEMAKER. TENSION WOOD CAUSES DIFFICULTY IN SEASONING AND MACHINING. Sth. Lumberman 201(2505): 31-34.

861.11

Schafer, E. R., and Pew, J. C. 1942. GRINDING AND NEWSPRINT PAPER EXPERIMENTS ON SOUTHERN SUGARBERRY, ASH, COTTONWOOD, WILLOW, AND ELM. U. S. For. Serv. For. Prod. Lab., Madison Mimeo No. R1410, 4 pp.

861.15

McGovern, J. N., and Keller, E. L. 1942. SULFITE PULPS FROM SEVERAL SOUTHERN HARDWOODS. U. S. For. Serv. For. Prod. Lab., Madison Mimeo No. R1409, 5 pp. Bblg.

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

902 HISTORY OF FORESTS AND FORESTRY

Fournier, P. 1954. HISTOIRE DU POPULUS EUPHRATICA OLIV. [HISTORY OF P. EUPHRATICA.] Bull. Soc. Bot. France 101(1/2): 6-8. [F.]
A review based on literature.

945.35

Giordano, E. 1959(1960). IL POPULUS DELTOIDES BARTR. NEL SUO PAESE DI ORIGINE. NOTA PRELIMINARE SU UN VIAGGIO DI STUDIO. [P. DELTOIDES IN ITS NATIVE HABITAT. PRELIMINARY NOTE ON A STUDY TOUR.] Pubbl. Cent. Sper. Agric. For., Roma No. 3: 127-80. 55 refs. [It.it.e.e.]
Notes on a tour made by the author in the U.S.A. in 1958, giving particular attention to natural stands of P. deltoides in the lower Mississippi, Louisiana, Arkansas, and Illinois. Visits were also made to stands of natural hybrids of P. alba × P. grandidentata and plantations of artificial hybrids

P. GRANDIDENTATA TO P. JAPONO-GIGAS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

114.351

Schnitzer, M., and Delong, W. A. 1955. INVESTIGATIONS ON THE MOBILIZATION AND TRANSPORT OF IRON IN FORESTED SOILS. II. THE NATURE OF THE REACTION OF LEAF EXTRACTS AND LEACHATES WITH IRON. Proc. Soil Sci. Soc. Amer. 19(3): 363-8. 13 refs.

160.22

Pearl, I. A., and Darling, S. F. 1963. STUDIES ON THE LEAVES OF THE FAMILY SALICACEAE. II. QUERCETIN-3—GLUCOSIDURONIC ACID FROM POPULUS GRANDIDENTATA LEAVES. J. Organ. Chem. 28(5): 1442. 4 refs.

———— Darling, S. F., and Justman, O. 1962. STUDIES ON THE LEAVES OF THE FAMILY SALICACEAE. I. POPULIN FROM THE LEAVES OF POPULUS GRANDIDENTATA AND POPULUS TREMULOIDES. J. Organ. Chem. 27(7): 2685-7. 11 refs.

Pridham, J. B. 1960. OLIGOSACCHARIDES AND ASSOCIATED GLYCOSIDASES IN ASPEN TISSUES. Biochem. J. 76(1): 13-7. 43 refs.

161.2

Faust, M. E. 1936. GERMINATION OF POPULUS GRANDIDENTATA AND P. TREMULOIDES, WITH PARTICULAR REFERENCE TO OXYGEN CONSUMPTION. Bot. Gaz. 97(4): 808-21. Plant Sci. Lit. 4(1): 5. 1936.

164.5

Negisi, K., Yagi, K., and Satoo, T. 1958. [SEASONAL VARIATION IN LEAF SIZE OF YOUNG POPLAR PLANTS WITH SPECIAL REFERENCE TO HEIGHT GROWTH.] J. Jap. For. Soc. 40(12): 499-504. 3 refs. [Jap.jap.e.e.]
Presents data based on observations made mainly on Populus japano-gigas, the total leaf area of which was measured at 10-day intervals by the "dot-counting" method and studied in relation to the mean increases in leaf size and stem height occurring over the same periods.

164.6

Cavanagh. 1931. ABNORMAL FLOWERS OF P. GRANDIDENTATA. Bot. Cur. Lit. 13(21): 20.

165.41

Konovalov, N. A. 1960. URAL'SKAJA PIRAMIDAL'NAJA OSINA. [THE URALS FASTIGIATE ASPEN.] Lesn. Z., Arhangel'sk 3(3): 156-7. 4 refs. [Russ.]
A brief description of the hybrid, produced by crossing Populus tremula male with P. jablokowii (i.e. P. tremula × P. bolleana), with notes on its propagation. It is a decorative, frost-resistant tree, of interest for park and street planting.

165.5

Barnes, B. V. 1959. NATURAL VARIATION AND CLONAL DEVELOPMENT OF POPULUS TREMULOIDES AND P. GRANDIDENTATA IN NORTHERN LOWER MICHIGAN. Abstr. of thesis, in Dissert. Abstr. 20(5): 1511-2. [Univ. Mich.]

165.71

Barnes, B. V. 1961. HYBRID ASPENS IN THE LOWER PENINSULA OF MICHIGAN. Rhodora 63(755): 311-24. 18 refs.

Einspahr, D. W. 1962. EUROPEAN WHITE POPLAR-BIGTOOTH ASPEN HYBRID IN WISCONSIN. J. For. 60(5): 345. 3 refs.
Describes a natural hybrid developed under fairly open conditions on a moist sandy site. Height at 17 years was 70 ft., d.b.h. 13.7 in., sp. gr. 0.389, fibre length 0.96 mm., chromosome number 38. The tree is bisexual. Sprouts propagated from this tree are being studied.

Little, E. L., Jr., Brinkman, K. A., and McComb, A. L. 1957. TWO NATURAL IOWA HYBRID POPLARS. For. Sci. 3(3): 253-62. 16 refs.

McComb, A. L., and Hansen, N. J. 1954. A NATURALLY OCCURRING ASPEN-POPLAR HYBRID. J. For. 52(7): 528-9.
Cites map references in Iowa for two stands of Populus grandidentata × alba of good form, rapid growth and apparent disease resistance, for one of which a stand and stock table is given (800 trees and 3,500 cu.ft./acre, 3-9 in. diam., 34-74 ft. with m.a.i. of 145 cu. ft. at 24 yrs., 3½ times as fast as oak of same age.

Pauley, S. S. 1956. NATURAL HYBRIDIZATION OF THE ASPEN [: POPULUS TREMULOIDES AND P. GRANDIDENTATA]. Minn. For. Note No. 47, 2 pp.

176.1

Rouleau E. 1948. TWO NEW NAMES IN POPULUS (: P. BALSAMIFERA L. VAR. FERNALDIANA NOM. NOV. (P. BALSAMIFERA VAR. MICHAUXII HENRY) AND × P. GILEADENSIS STAT. ET NOM NOV. (BALSAMIFERA × DELTOIDES VAR. MISSOURIENSIS?; P. CANDICANS SENSU MICHX).) Rhodora 50(597): 233-6.

Vazquez, Gonzalez. 1931. NOTE ON P. ILLICITANA IN SPAIN. Bot. Cur. Lit. 13(12): 32.

181 MODE OF LIFE, AUTECOLOGY, SILVICULTURAL CHARACTERS OF TREES

Anonymous. 1908. SWAMP COTTONWOOD (P. HETEROPHYLLA). U. S. For. Serv. Silv. Leafl. No. 40.

Slabaugh, P. E. 1958. SILVICAL CHARACTERISTICS OF BIGTOOTH ASPEN (POPULUS GRANDIDENTATA). U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 63, 16 pp. 50 refs.

181.3

Stoeckeler, J. H. 1948. THE GROWTH OF QUAKING ASPEN AS AFFECTED BY SOIL PROPERTIES AND FIRE. J. For. 46(10): 727-37. 17 refs.

181.521

Cavanagh. 1933. ABNORMAL FLOWERS OF P. GRANDIDENTATA. Biol. Abstr. 7: 1762.

Einspahr, D. W. 1960. ABNORMAL FLOWERING BEHAVIOR IN ASPEN. Iowa St. Coll. J. Sci. 34(4): 623-30. 15 refs.
Describes and illustrates branched staminate catkins and hermaphroditism in Populus tremuloides, and late flowering in P. grandidentata and P. tremuloides.

———— and Joranson, P. N. 1960. LATE FLOWERING IN ASPEN AND ITS RELATION TO NATURALLY OCCURRING HYBRIDS. For. Sci. 6(3): 221-4. 8 refs.
Reports, with illustrations, the flowering of ♂ and ♀ catkins of P. tremuloides 10 days later than the rest and providing thereby the necessary time bridge to explain local hybridization with P. grandidentata. [*See Pauley, 1956, P. grandidentata to P. japono-gigas, 165.71.*]

2 SILVICULTURE

221.1

Reinke, M. E. 1955. MANAGEMENT OF ASPEN. Wis. Conserv. Bull. 20(11): 25-8.
Recommends clear felling for aspen (both bigtooth and trembling aspen) at maturity, which is reached in Wisconsin stands at ca. 40-50 years. Yields vary from 5 to 25 cords/acre depending on the soil moisture and fire history of the stand.

231 NATURAL REGENERATION

Green, A. W. 1961. PROMOTING THE SPREAD OF BIGTOOTH ASPEN [POPULUS GRANDIDENTATA] IN IOWA. U. S. For. Serv. Cent. St. For. Exp. Sta., Sta. Note No. 149, 2 pp.
The size of small bigtooth aspen pockets in low-grade hardwood stands can be increased by clear-felling existing aspens and cutting or killing (depending on merchantability) the adjacent hardwoods. After 3 years, this treatment increased aspen sprout and seedling populations on treated areas from 40 to 5,000/acre; disking the areas did not affect the results. Weed competition is usually outstripped.

231.5

DeByle, N. V. 1962. TRACING AND EVALUATING FUNCTIONAL ROOT CONNECTIONS AMONG STEMS WITHIN ASPEN CLONES. Abstr. of thesis in Dissert. Abstr. 23(1): 9-10. [Univ. Mich.]

Farmer, R. E., Jr. 1962. SOME PHYSIOLOGICAL ASPECTS OF ROOT SUCKER INITIATION AND EARLY GROWTH IN POPULUS TREMULOIDES AND P. GRANDIDENTATA. Abstr. of thesis, in Dissert. Abstr. 23(1) 10. [Univ. Mich.]

———— 1962. ASPEN ROOT SUCKER FORMATION AND APICA DOMINANCE. For. Sci. 8(4): 403-10. 23 refs.

———— 1962. DEPTH AND DIAMETER OF THE PARENT ROOT OF ASPEN ROOT SUCKERS. Mich. For. No. 23, 4 pp.
A study was made on Populus tremuloides (a) and P. grandidentata (b) root suckers. On the whole, (a) suckered nearer t soil surface and from smaller roots than (b) which occupies t whole A_1 horizon more completely. This difference probab accounts for the advantage of (b) over (a) on shallow dry sit

Stoeckeler, J. H., and Macon, J. W. 1956. REGENERATION OF ASPEN CUTOVER AREAS IN NORTHERN WISCONSIN. J. For. 54(1): 13-6. 9 refs.

Westell, C. E., Jr. 1961. THE ECOLOGY OF DEER AND ASPEN IN LOWER MICHIGAN. Abstr. of thesis, in Dissert. Abstr. 21(8): 2067-8. [Univ. Mich.]

232.1

Vasquez. 1929. P. ILLICITANA IN SPAIN. Biol. Abstr. 3: 21356.

232.311.3

Shea, K. R., and Riker, A. J. 1954. BREEDING POPLARS FOR DISEASE RESISTANCE. Abstr. in Phytopathology 44(9): 505.

232.32

Einspahr, D. W. 1959. NURSERY PRODUCTION OF ASPEN SEEDLING. U. S. For. Serv. Tree Plant. Notes No. 35: 22-4. 1 ref.
Experiments indicate that seedlings of Populus tremuloides and P. grandidentata suitable for field planting can be obtained in one season by sowing in sterilized seedbeds covered with a layer of acid sand; daily watering and screening against rain drops are necessary until early July, when the screens are removed and watering done twice weekly.

232.328.1

Farmer, R. E., Jr. 1963. VEGETATIVE PROPAGATION OF ASPEN BY GREENWOOD CUTTINGS. J. For. 61(5): 385-6. 8 refs.

Negisi, K., Yagi, K., and Satoo, T. 1958. [STUDIES IN THE GROWTH OF YOUNG PLANTS OF POPLAR [POPULUS JAPANO-GIGAS] ARISING FROM CUTTINGS OF DIFFERENT THICKNESS. 1. SEASONAL COURSE IN DRY WEIGHT INCREMENT.] J. Jap. For. Soc. 40(10): 421-37. 3 refs. [Jap.e.e.]
Presents extensive graphical data [in English] showing the growth of young P. japano-gigas from cuttings of various thicknesses, as observed mainly by their changes in weight in the first season of growth.

[U.S.A.: Cent. St. For. Exp. Sta.] 1959. VEGETATIVE PROPAGATION OF POPLARS. Rep. U. S. For. Serv. Cent. St. For. Exp. Sta. 1958: 33-4.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

322.3

Lohrey, R. E. 1959. DEBARKING BIGTOOTH ASPEN WITH 2,4-D AMINE SALT. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 550, 2 pp.
Tests showed that 2,4-D applied weekly at full strength or in a 50% water solution to frill girdles was an effective substitute for Na arsenite, and loosened aspen bark until the end of July. A 25% concentration was effective only during treatments in June.

33 DEGREE OF UTILIZATION AND WASTE

Ralston, R. A. 1953. COMPARISON OF MAN HOURS REQUIRED FOR THINNING AND CLEAR CUTTING POLE-SIZE ASPEN. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 407, 1 p.
Results of a time study showing logging time per cord for low thinning (diam. below 7 in.) crown thinning (diam. above 7 in.), and clear felling in a 50-acre block of Populus grandidentata averaging 22 cords/acre are tabulated. Figures were 4.0, 3.6, and 3.0 man-hr./cord respectively.

4 FOREST INJURIES AND PROTECTION

443 FUNGI AND BACTERIA

Gruenhagen, R. H. 1945. HYPOXYLON PRUINATUM AND ITS PATHOGENESIS ON POPLAR. Phytopathology 35(1): 72-89. Bblg.

443.3

Graham, S. A., and Harrison, R. P. 1954. INSECT ATTACKS AND HYPOXYLON INFECTIONS IN ASPEN. J. For. 52(10): 741-3.
In ca. 95% of 138 Hypoxylon pruinatum cankers on the main stems of Populus tremuloides and P. grandidentata the original seat of infection was insect damage (Saperda calcarata 30%, Dicerca tenebrica 15, Agrilus 15, Lepidoptera 14). Silvicultural control is suggested.

Dance, B. W. 1961. SPORE DISPERSAL IN POLLACCIA RADIOSA (LIB.) BALD. AND CIF. Canad. J. Bot. 39(6): 1429-35. 3 refs.

Silverborg, S. B. 1959. RATE OF DECAY IN NORTHERN HARDWOODS FOLLOWING ARTIFICIAL INOCULATION WITH SOME COMMON HEARTROT FUNGI. For. Sci. 5(3): 223-8. 7 refs.

44/45

Harrison, R. P., Jr. 1960. THE INSECTS AND DISEASES OF ASPEN. Abstr. of thesis, in Dissert. Abstr. 20(12): 4478-9. [Univ. Mich.]

453 INSECTS

Nishiguchi, C. 1958. [ON THE COMMUNITIES OF POPULUS DEFOLIATORS AND THEIR SEASONAL CHANGE.] Bull. Tokyo Univ. For. No. 54: 191-8. 19 refs. [Jap.e.]
A study was made on Populus japano-gigas throughout the growing seasons of 1956 and 1957, to analyze the communities of defoliators (in the larval stage) and their seasonal change. The most important defoliators were: June Malacosoma neustria, July Lymantria dispar, August Melalopha anastomosis, Sept. and Oct. Notodonta tritophus.

5 FOREST MENSURATION

526.1

Haygreen, J. 1959. DRY WEIGHT OF GREEN ASPEN BOLTS. For. Prod. J. 9(1): 38-42. 13 refs.

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Graham, S. A., and Harrison, R. P. 1955. SITE IDENTIFICATION FOR BIGTOOTH ASPEN SUCKER STANDS. Mich. For. No. 10, 4 pp.
Tabulates site quality data for Populus grandidentata on well-drained sandy soils, expressed as total height at 30 years, which varies from 30 ft. on the poorest to over 90 ft. on the best sites.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Dode. 1932. NOTES ON GROWTH OF P. ILLICITANA. Biol. Abstr. 6: 22963.

6 FOREST MANAGEMENT

613 EXPLOITABILITY AND ROTATION

Brinkman, K. A., and Krajicek, J. E. 1952. NATURAL MORTALITY AND CULL IN BIGTOOTH ASPEN STANDS IN NORTHEASTERN IOWA. U. S. For. Serv. Cent. St. For. Exp. Sta., Sta. Note No. 69, 2 pp.
A study on 50- and 80-year unmanaged stands of Populus grandidentata from 1948 to 1951 showed a rapid decline in the numbers of living and of sound trees per acre from 50 years onwards.

8 FOREST PRODUCTS AND THEIR UTILIZATION

810 GENERAL INFORMATION ON WOOD

Betts, H. S. 1943. AMERICAN WOODS: ASPEN. U. S. For. Serv. 9 pp. Bblg.

811.12

Isenberg, I. H. 1956. THE FINE STRUCTURE OF THE CAMBIAL WALL OF BIGTOOTH ASPEN. Tappi 39(12): 882-3. 5 refs.
Under the electron microscope, the cambial wall of Populus grandidentata showed a random disperse orientation of microfibrils.

813.11

Pearl, I. A. 1957. THE NATURE OF ASPEN LIGNIN. For. Prod. J. 7(2): 88-90. 1 ref.

813.14

Thompson, J. O., and Wise, L. E. 1952. SOME MOLECULAR PROPERTIES OF THE HEMICELLULOSES OF BIG TOOTH ASPEN. Tappi 35(7): 331-6. 22 refs.

815.3

Inokuma, T., Shimaji, K., and Hamaya, T. 1956. [STUDIES ON POPLARS. (1) MEASUREMENT ON FIBER-LENGTH AND SPECIFIC GRAVITY OF JAPANESE GIANT POPLAR (POPULUS JAPONO-GIGAS).] Misc. Inform. Tokyo Univ. For. No. 11: 77-86. 7 refs. [Jap.e.e.]
The general trend in fibre length (1) with distance from the pith in a 3-year plant agreed with the findings of Sanio (1872) and Amos et al. Length decreased constantly from soil level up. No regular variation in specific gravity was found. Both length and sp. gr. were extrapolated for the 10-year plant for comparison with those of 6 softwoods and 8 hardwoods used in the Japanese pulp industry.

839.9

Anderson, E. A., and Hrubesky, C. E. 1949. UTILIZATION OF FARM WOODLOT WOODS FOR ROOFING FELT. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. R1739, 10 pp.

892.49

Pearl, I. A., and Darling, S. F. 1962. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. V. GRANDIDENTATIN, A NEW GLUCOSIDE FROM THE BARK OF POPULUS GRANDIDENTATA. J. Organ. Chem. 27(5): 1806-9. 6 refs.

———— Justman, O., Beyer, D. L., and others. 1962. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. VI. FURTHER STUDIES ON THE HOT-WATER EXTRACTIVES OF POPULUS GRANDIDENTATA BARK. Tappi 45(8): 663-6. 10 refs.

P. LASIOCARPA TO P. NIGRA AND VARS.

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

160.29

Gerola, F. M., and Barbesino, M. 1956. RICERCHE SULL'INFLUENZA DELLA POLARITA E DELLA NEOFORMAZIONE DI APICI MERISTEMATICI SULL'ATTIVITA DEIDROGENOSICA DEI TESSUTI CAMBIO-LIBERIANI IN TALEE DI PIOPPO (POPULUS ITALICA). [THE EFFECT OF POLARITY AND OF THE FORMATION OF NEW MERISTEMATIC APICES ON DEHYDROGENASE ACTIVITY IN THE CAMBIUM AND PHLOEM OF POPLAR (P. NIGRA VAR. ITALICA) CUTTINGS.] Nuovo G. Bot. Ital. (n.s.) 63(2/3): 213-9. 13 refs. [It.e.]
Segments of branches were placed in sawdust, erect, horizontally, and upside down. Analysis of dehydrogenase activity revealed the presence of definite gradients which appeared to be related to the intrinsic polarity of the branches, the translocation of stimulating substances, and the appearance of meristematic apices. The stimulating action of shoot apices was much more intense than that of the root primordia.

161.2/3

Salageanu, N., and Galan-Fabian, D. 1961. ISSLEDOVANIJA PO PITANIJU OMELY OBYKNOVENNOJ. [INVESTIGATIONS ON THE NUTRITION OF VISCUM ALBUM.] Fiziol. Rast. 8(5): 547-54. 12 refs. [Russ.russ.e.]

161.4

Swan, H. S. D. 1958. THE INFLUENCE OF GIBBERELLIC ACID ON THE GROWTH AND DEVELOPMENT OF HYBRID POPLAR. Woodl. Res. Index Pulp Pap. Res. Inst. Can. No. 105, 20 pp. 5 refs.

161.8

Shapiro, S. 1949. REVERSAL OF POLARITY REGENERATED ROOTS ON STEM CUTTINGS OF POPULUS. Amer. J. Bot. 36(10): 803.

164.4

Kalbe, L. 1962. [INVESTIGATIONS INTO THE HISTOGENESIS OF THE GROWING POINT OF SHOOTS IN SOME DICOTYLEDONOUS WOODY SPECIES.] Flora, Jena 152(2): 279-314. [G.g.]
Includes studies of Populus nigra var. italica and Ilex aquifolium.

165.4

Suto, T. 1938. MEICTIC CHROMOSOMES IN POPULUS NIGRA AND TOISUSU CARDIOPHYLLA. Jap. J. Genet. No. 16: 304-6. Plant Breed. Abstr. 14: 1007.

165.41

Jablokov, A. S. 1956. PIRAMIDAL'NYE TOPOLI. [FASTIGIATE POPLARS.] Goslesbumizdat, Moscow & Leningrad. 58 pp. [Russ.]
Discusses the importance of fastigiate poplars for green-belt and street and roadside planting in the U.S.S.R.; their distribution in cultivation; trials in the breeding of quick-growing, frost-hardy varieties; and propagation.

Li, S.-W. 1960. PRIMENENIE MNOGOKRATNOGO OPYLENIJA V SELEKCII TOPOLEJ. [REPEATED POLLINATION IN POPLAR BREEDING.] Vestn. Sel'. -Hoz. Nauki 5(2): 140-3. 5 refs. [Russ.e.g.f.]

Nicota, B. 1962. [THE IMPROVEMENT OF POPULUS NIGRA VAR THEVESTINA.] Topola, Beograd 6(28): 50-4. 8 refs. [Serb.f.]

Preliminary experiments indicate that this poplar, which is common in Macedonia, can easily be crossed with other black poplars. It is proposed to experiment further in crosses with southern forms of P. deltoides. Attempted crosses with poplars of the section Leuce failed.

Pohl, Z. 1962. [STUDY ON THE GROWTH AND MORPHOLOGY OF THE KORNIK HYBRIDS OF POPULUS MAXIMOWICZII.] Arbor. Kornickie, Poznan 7: 115-87. 35 refs. [Pol.russ.e.e.]

165.5

Marjanovic, P. 1959. SPONTANI HIBRID ILI POSEBNA FORMA DOMACE CRNE TOPOLE. [A SPONTANEOUS HYBRID OR SPECIAL FORM OF THE NATIVE BLACK POPLAR.] Topola, Beograd 3(12): 1042-4. [Serb.]

165.51

Kraayenoord, C. W. S. van. 1959. THE CHILEAN OR SEMI-EVERGREEN LOMBARDY POPLAR. Farm For., Wellington 1(4): 88-9.
[Cf. F.A. 5, p. 22.] This variety was introduced into New Zealand from S. Africa in 1948. Its semi-evergreen habit makes it an excellent tree for shelter purposes, and cuttings grew 8-10 ft. in 1 year vs. 6 ft. for the common Lombardy poplar. It has so far been given no special botanical name. [Cf. Reinecke and Wicht, 1942, P. lasiocarpa to P. nigra and vars., 176.1.]

Li, C. -W. 1960. O FORMAH OSOKORJA V BASKIRII. [FORMS OF POPULUS NIGRA IN BASHKIRIA.] Lesn. Hoz. 12(1): 15-8. [Russ.]

165.62

Spalek, V. 1961. SCHWARZPAPPELN - POPULUS NIGRA L. VAR. TYP. CSSR. [P. NIGRA VAR. TYPICA IN CZECHOSLOVAKIA.] Commun. Inst. For. Csl. 2: 81-7. [G.]
A review of progress to date in the selection of elite individuals in Czechoslovakia and their use in breeding.

165.7

Cansdale, G. S. 1934. A CRITICAL INVESTIGATION OF THE BLACK POPLARS AND THEIR HYBRIDS AND OF CERTAIN MORPHOLOGICAL CHARACTERS IN THE GENUS. Typscr. 59 pp.

Vill. 1932. P. MONILIFERA AND HYBRIDS DERIVED FROM IT. Mitt. Dtsch. Dendrol. Ges. 44: 66.

165.71

Joachim, H. F. 1958. UBER DIE SPREEWALD-PAPPEL. [THE 'SPREEWALD' POPLAR.] Silvae Genet. 7(1): 25-30. 8 refs. [G.g.e.f.]

Jovanovic, S. 1957. PRIRODNA HIBRIDIZACIJA IZMEDU TOPOLA × P. MARILANDICA I × P. SEROTINA. [NATURAL HYBRIDIZATION BETWEEN POPULUS × MARILANDICA AND P. × SEROTINA.] Topola, Beograd No. 4: 294-7. [Serb.]
Records a case in Yugoslavia of presumed natural fertilization of P. × marilandica by P. × serotina (no other male trees existed within a radius of 4-5 km.), and recommends planting these varieties in mixture to form a source of hybrid seed for progeny trials.

176.1

Anonymous. 1908. FEMALE LOMBARDY POPLAR. Forstwiss. Cbl. May, p. 293.

———— 1919. BLACK POPLAR (P. SEROTINA). Quart. J. For. 13: 137.

———— 1933. NOTE ON P. NIGRA. Mitt. Dtsch. Dendrol. Ges. 45: 342.

Clonaru, A., and Ocskay, S. 1955. UN NOU PLOP PIRAMIDAL IN FLORA R.P.R.: POPULUS NIGRA L. VAR. THEVESTINA (DODE, BEAN). [A NEW PYRAMIDAL POPLAR IN THE FLORA OF RUMANIA: P. NIGRA VAR.THEVESTINA.] Bul. Sti. Acad. Repub. Rom. (Sect.Biol.) 7(4): 981-97. 11 refs. [Rum.russ.f.]
This poplar has recently been identified in the South of Rumania, where it is common on poor, sandy soils. All trees appear to be female. Its value as a source of pulpwood is discussed.

Davy, Burtt. 1930. NOTE ON THE LOMBARDY POPLAR. Emp. For. 9: 269.

Dzekov, S. 1959/1960(1960). DOMASNATA CRNA TOPOLA (POPULUS NIGRA L.) VO NR MAKEDONIJA. [THE NATIVE P. NIGRA IN MACEDONIA.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) No. 13: 5-48. 33 refs. [Maced.maced.g.]
A study of the taxonomy, morphology, distribution, and ecology of varieties and forms of P. nigra native to Macedonia.

———— 1960. ODOMACENA PIRAMIDALNA TOPOLA U NR MAKEDONIJI P. PANNONICA KIT. SYN. P. THEVESTINA DODE, P. THRACIA DODE. [THE FASTIGIATE POPLAR NATURALIZED IN MACEDONIA, POPULUS PANNONICA (= P. NIGRA VAR. THEVESTINA, P. THRACIA).] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 1: 89-126. 14 refs. [Serb.serb.g.]

Fankhauser. 1904. ON THE SWISS POPLAR: P. MONILIFERA. J. For. Suisse 55: 84-9.

He[d]jazi, R., Tabatabai, M., Niloofari [Nilufari], P., and others. 1957. STUDY ON A POPLAR TREE IN IRAN (POPULUS NIGRA VAR. PYRAMIDALIS ROZ.). Bull., For. & Wood Tech. Lab., Univ. Teheran No. 12, 72 pp. 13 refs. [Per.e.e.]

Henry. 1916. THE BLACK POPLARS. Trans. Scot. Arbor. Soc. 30: 14.

Jovanovic, B., and Tucovic, A. 1957. O JEDNOJ TOPOLI NOVOJ ZA FLORU JUGOSLAVIJE. [A POPLAR NEW TO THE FLORA OF YUGOSLAVIA.] Sumarstvo 10(3/4): 189-206. 15 refs. [Serb.e.f.]
A preliminary account of an apparently new pubescent form of P. nigra, of spreading habit, found in the Neretva valley near Capljina.

Lagershausen. 1929. DIFFERENCES BETWEEN P. MONILIFERA AND P. CANADENSIS. Dtsch. Forstztg. 44: 365.

Li, H. -L. 1958. THE WEEPING WILLOW AND LOMBARDY POPLAR. Morris Arbor. Bull., Philadelphia 9(1): 3-9. 12 refs.
Discusses their habit, origin, taxonomic position, introduction into various countries, diseases, etc., including, for the poplar, clonal senescence (the evidence for this is not now considered so strong as it appeared to be earlier).

Muller, R. 1961. ALTSTAMMSORTEN DER SCHWARZPAPPELBASTARDE. IIV. NEUSORTEN AUS ALTSTAMMEN UND FREMDE ALTSORTEN. ['OLD STOCK' VARIETIES OF BLACK POPLAR HYBRIDS. IIV. NEW VARIETIES FROM 'OLD STOCKS', AND FOREIGN 'OLD STOCK' VARIETIES.] Holz-Zbl. 87(21): 319-24. 21 refs. [G.]

Rehder. 1928. P. PILOSA FROM E. ALTAI MTS. Biol. Abstr. 2: 13203.

Reinecke, O. S. H., and Wicht, C. L. 1942. A SEMI-EVERGREEN FORM OF LOMBARDY POPLAR. J. S. Afr. For. Ass. No. 9: 19-22. Bblg.

Schwerin. 1907. NOTES ON FEMALE LOMBARDY POPLARS. Mitt. Dtsch. Dendrol. Ges. 16: 288.

Smith, and Taylor. 1908. NOTE ON THE LOMBARDY POPLAR (P. PYRAMIDALIS ROZ.). The Naturalist, July.

Stoyanoff [Stojanov], V., and Entscheff [Encev], E. 1959. POPULUS PRZEWALSKII UND IHR HOLZ. [P. PRZEWALSKII AND ITS WOOD.] Wissenschaftliche Zeitschrift der Technischen Hochschule Dresden 8(3): 580-4. 8 refs. [G.g.]

Valenzuela, R. H. 1953. EL ALAMO EN CHILE. [POPLAR IN CHILE.] Chile Maderero 3(15): 6. [Span.]
The most widely cultivated poplar in Chile is Populus nigra var. italica. Brief notes are presented on the soils in which it grows, uses of the wood, establishing and tending plantations and yields of timber.

Vasilic, V. 1957. JEDNO OBAVESTENJE O T.ZV. RITISEVSKOJ TOPOLI. [A REPORT ON THE "RITISEVO" POPLAR.] Topola, Beograd No. 4: 298-301. [Serb.]
This variety, existing in both sexes, is said to show better rooting ability and height growth, but a more crooked stem, than P. × serotina, which it was at first taken to be. No firm data can yet be given on its wood properties, as it has only been grown in nurseries and plantations for 10 years.

Vill. 1936. NOTE ON POPULUS MONILIFERA. Dtsch. Forstw. 18 (79): 975-76. [G.]

Wolterson, J. F. 1961. POPULUS NIGRA L. IN NEDERLAND. [P. NIGRA IN THE NETHERLANDS.] Ned. Boschb.-Tijdschr. 33(10): 281-

97. 8 refs. [Du.du.e.e.]
Discusses its distribution and uses (e.g. for avenues, boundaries and on sand-dunes) in plantings in the Netherlands, site requirements, identification (in some detail), variability of the material, and the potential value of the collection of clones in the Netherlands for breeding.

Zederbauer. 1908. FEMALE LOMBARDY POPLAR. Centralbl. f.d.g. Forstw. 34: 118.

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Holmgren, N. T. 1946. ESTUDIO DEL ALGUNOS DE LOS FACTORES QUE INFLUYEN SOBRE EL CRECIMENTO DEL ALAMO. [STUDY OF SOME OF THE FACTORS WHICH INFLUENCE THE GROWTH OF POPLAR.] Agricultura Tec., Santiago 6(1): 54-66. [Span.e.]

Jovanovic, B. 1957. O JEDNOJ MALO POZNATOJ TOPOLI (POPULUS THEVESTINA DODE). [A LITTLE-KNOWN POPLAR (P. NIGRA VAR. THEVESTINA).] Sumarstvo 10(1/2): 63-70. 16 refs. [Serb.e.f.]
Notes on the morphological characters and ecology of this poplar, which is found in S. and S.W. Yugoslavia.

Khoroshikh, P. P. 1948. CHERNY TOPOL' V NARYME. [POPULUS NIGRA IN THE NARYM REGION.] Priroda 37(2): 63. 2 refs. [Russ.]

Puri, G. S. 1945. LOMBARDY POPLAR (POPULUS NIGRA VAR. FASTIGIATA DESF.) IN INDIA. Indian For. 71(12): 423-5. Bblg.

Schmitz-Lenders, B. 1953. PAPPELPROBLEME. [POPLAR PROBLEMS.] Forst u. Holz. 8(2; 3): 13-20; 29-32. [G.]

181.1

Clark. 1931. EXTENSION OF RANGE OF DOWNY POPLAR IN U.S.A. Bot. Cur. Lit. 13(17): 31.

Gusev, Ju. D., and Sidorov, L. F. 1960. K EKOLOGII POPULUS PAMIRICA KOM. NA VERHNEM PREDELE EGO PROIZRASTANIJA. [ECOLOGY OF P. PAMIRICA AT THE UPPER LIMIT OF ITS RANGE.] Bot. Z. 45(3): 444-5. 2 refs. [Russ.]

181.3

Kriebel, H. B., Lowry, G. L., and Murphey, W. K. 1958. RELATIONSHIP OF SITE CONDITIONS TO ESTABLISHMENT AND EARLY GROWTH OF MCKEE HYBRID POPLAR. Res. Circ. Ohio Agric. Exp. Sta. No. 53, 11 pp.

181.31

Takatoi, I. and Toyooka, H. 1953. [THE RELATIONS BETWEEN GROWTH OF JAPANESE BIRCH AND DORO POPLAR AND THE HEIGHT OF THE GROUND WATER.] In Symp., Ann. Staff Conf., Sapporo Br., Govt. For. Exp. Sta., 1952: 85-102. [Jap.jap.e.]
Discusses the effect on height and root growth of Betula tauschii and Populus maximowiczii growing on forest loam, peat and mixed soils, of different heights of underground water. [From authors' summary.]

181.311

Schmitz-Lenders, B. 1959. REAKTION DER PAPPEL AUF GRUNDWASSER-ABSENKUNG UND NEUE ERKENNTNISSE BETREFFEND DEN ZUWACHSGANG IN HARFFER-PAPPEL—WEITVERBAND-BESTANDEN DES NIEDERRHEIN-GEBIETES. [THE REACTION OF POPLARS TO A LOWERING OF THE WATER TABLE, AND NEW LIGHT ON THE COURSE OF INCREMENT IN WIDELY SPACED STANDS OF THE HARFF POPLAR [POPULUS × REGENERATA] IN THE LOWER RHINE REGION.] Allg. Forst- u. Jagdztg. 130(7): 201-4. 2 refs. [G.]

———— 1961. REGENERATION IM ZUWACHS DURCH GRUNDWASSERABSENKUNG GESCHADIGTER HARFFER PAPPELN. [RECOVERY OF INCREMENT OF "HARFF" POPLARS INJURED BY A LOWERING OF THE WATER TABLE.] Allg. Forst- u. Jagdztg. 132(4): 102-4. 2 refs. [G.e.]
Re-examination of the trial plots showed a recovery particularly in height and volume increment, in the last 3 years, though not quite to the former level, and confirmed the previous yield forecasts.

181.35/36

Truszkowska, W. 1961. ORIENTACYJNE BADANIA MIKOFLORY NAJMIODSZYCH CZESCI SYSTEMU KORZENIOWEGO TOPOL (POPULUS EURAMERICANA MARILANDICA BOSC) Z ROZNYCH STANOWISK W TURWI. [A MYCOLOGICAL STUDY OF ROOTLETS AND YOUNG ROOTS OF P. × CANADENSIS VAR. MARILANDICA FROM DIFFERENT SITES AT TUREW (NEAR POZNAN).] Acta Soc. Bot. Polon. 30(3/4): 395-421. 22 refs. [Pol.pol.f.]

181.36

Shapiro, S. 1955. LIGHT INHIBITION OF ROOTS ON STEM SEGMENTS OF THE LOMBARDY POPLAR. Abstr. in Plant Physiol. 30(Suppl.): 8-9.

181.52

Kobendza, R. 1955. OKAZY ZENSKIE TOPOLI PIRAMIDALNEJ W POLSCE. [FEMALE SPECIMENS OF POPULUS NIGRA VAR. ITALICA IN POLAND.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 10: 191-207. 19 refs. [Pol.russ.e.]
Describes specimens found in Warsaw and environs. They are of two types: (1) with a narrow pyramidal crown reaching the base of the stem, and (2) with a much broader, more open crown which begins at a certain height above ground level. The latter might be of hybrid origin.

181.521

Jovanovic, B., and Tukovic, A. 1962. [AN UNUSUAL OCCURRENCE OF MONOECISM IN POPLUS NIGRA L.] Topola, Beograd 6(28): 46-50. 7 refs. [Serb.g.]
Gives an account of a tree consisting of three stems of coppice origin, two of which bear catkins only, while the tallest, middle stem bears ♀, ♂ and ☿.

Nicota, B. 1961. POJAVA DVOPOLNIH CVETOVA KOD P. THEVESTINA DODE. [THE OCCURRENCE OF BISEXUAL FLOWERS IN POPULUS NIGRA VAR. THEVESTINA.] Topola, Beograd 5(22/23): 17-8. 7 refs. [Serb.f.]
Describes the three trees in Macedonia (aged 25-32) on which the flowers were found, with some phenological data, and discusses the significance of the find for breeding. [Cf. May, 1959, P. deltoides to P. generosa, 181.521.]

181.525

Ustanov, A. U. 1961. K BIOLOGII PRORASTANIJA SEMJAN SIZOGO TOPOLJA PETTY (POPULUS PRUINOSA SCHRENK.). [BIOLOGY OF GERMINATION IN SEEDS OF P. PRUINOSA.] Dokl. Akad. Nauk Uzbekskoj SSR, Taskent 1961(4): 54-6. [Russ.uzb.]
Briefly reports data on laboratory germination, distinguishing (by color) eight kinds of seed, as well as germination in pots outdoors. In nature, many of the seeds fall into rivers; the seeds can live in water for 15-20 days, where they begin to germinate.

181.61

Milovanovic, M. 1957. JEDNA ZALOSNA CRNA TOPOLA NA OMOLICKOM FORLANDU. [A WEEPING BLACK POPLAR AT OMOLICKO FORLAND.] Topola, Beograd No. 3: 205-9. [Serb.f.]
Describes, with a photograph, a specimen of P. nigra f. pendula, situated on the banks of the Danube, near Pancevo. It has a height of 14 m. and a d.b.h. of 112 cm. and has grown from a stump cut ca. 40 years ago. Morphological data are given. Attempts at vegetative propagation are being made.

181.71

Anonymous. 1925. A FINE LOMBARDY POPLAR. Timb. Tr. J. 1: 62.

Florian-Larsen, P. C., and Lange, J. 1955. "STOREPIL" PA HERLUFSHOLM: EN BEROMT SORTPOPPEL, POPULUS NIGRA L. [THE "STOREPIL" AT HERLUFSHOLM: A FAMOUS SPECIMEN OF P. NIGRA.] Dansk Dendrol. Arsskr. 3: 270-5. 7 refs. [Dan.]
Notes on a veteran tree which fell in the storm of Jan. 20, 1954, aged between 265 and 270 years. In its prime (1824-46) its heigh was ca. 40 m.; in 1900 its diameter at 2 m. was 25-½ Danish ft [1 Danish ft. = ca. 0.314 m.]; and after that date it was onl kept standing by special repairs and lopping.

181.75

Herrmann, S., and Meyer, H. 1959. ZUR FRAGE DER "KLONALTI RUNG" BEI PYRAMIDENPAPPELN. [THE PROBLEM OF "SENESCENCE C CLONES" IN POPULUS NIGRA VAR. ITALICA.] Allg. Forstzeitschr. 1 (9): 196-8. 16 refs. [G.]

181.8

Gerola, F. M., and Barbesino, M. 1956. L'ATTIVITA DEIDROGENASICA DEL CAMBIO IN DIFFERENTI PERIODI DELL'ANNO IN CORYLUS, POPULUS E PRUNUS. [THE DEHYDROGENASE ACTIVITY OF THE CAMBIUM AT DIFFERENT SEASONS OF THE YEAR IN CORYLUS, POPULUS, AND PRUNUS.] Nuovo G. Bot. Ital. (n.s.) 63(1): 37-45. 37 refs. [It.it.e.]
Using a tetrazolium staining technique, seasonal changes in dehydrogenase activity were determined in the cambium and phloem of branches of C. avellana, Populus nigra var. italica, and Prunus avium. Maximum activity occurred in spring and autumn, coinciding with maximum cambial cell activity and maximum accumulation of reserves respectively. A gradient of activity was found along the branch, reaching a maximum at the apex.

Hacskaylo, J., and Murphey, W. K. 1958. GROWTH SUBSTANCES. RESPONSE OF 9-YEAR-OLD MCKEE HYBRID POPLAR TO GIBBERELLIC ACID. Res. Circ. Ohio Agric. Exp. Sta. No. 54, 8 pp. 3 refs.

Tucovic, A. 1954. PRILOG POZNAVANJU CRNIH TOPOLA U BEOGRADU I OKOLINI. [POPULUS NIGRA IN BELGRADE AND ITS VICINITY.] Sumarstvo 7(11/12): 638-49. 14 refs. [Serb.e.g.]
Some tabulated phenological data (flowering, flushing, leaf-fall, and fruiting) are given for the local Populus nigra, P. nigra var. pyramidalis, the same with female catkins, P. nigra var. betulifolia, and P. nigra var. plantierensis.

Walter. 1931. P. NIGRA LEAVES REMAINING GREEN UNTIL CHRISTMAS. Mitt. Dtsch. Dendrol. Ges. 43: 420.

2 SILVICULTURE

Alviella, G. d'. 1947. LA CULTURE DU PEUPLIER. [THE CULTIVATION OF THE POPLAR.] Bull. Soc. For. Belg. 54(3/4): 97-128. [F.]

Georgiev, Z. 1945. VURHU PRIRASTA NA TOPOLOVITE, VURBOVITE I DUBOVITE NASAZDENIJA V DUNAVSKITE OSTROVI "BELENE" I "VARDIM." [GROWTH OF POPLAR, WILLOW AND OAK STANDS ON THE DANUBIAN ISLANDS OF BELENE AND VARDIM.] Gorsko Stopanstvo 1(1/2): 22-4. [Bulg.]

Soljanik, I. 1960. BELI JABLAN (POPULUS THEVESTINA DODE) U USLOVIMA AKMO. [P. NIGRA VAR. THEVESTINA IN THE CONDITIONS OF KOSOVO-METOHIJA.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 2: 69-82. 23 refs. [Serb.f.]
This poplar has probably been used more than any other for planting in the region, chiefly in shelterbelts. Brief data on distribution, future planting programs, timber production, price, etc., are given.

228.7

Matsui, Z. 1955. [SILVICULTURAL STUDIES OF DORO-POPLAR [P. MAXIMOWICZII] IN HOKKAIDO.] Res. Bull. Exp. For. Hokkaido Univ. 17(2): 665-714. 15 refs. [Jap.e.]

23 REGENERATION AND FORMATION OF STANDS

Schwerin. 1931. REGENERATION OF P. LASIOCARPA. Mitt. Dtsch. Dendrol. Ges. 43: 406.

231 NATURAL REGENERATION

Popelka. 1930. REGENERATIVE ACTIVITY OF P. PYRAMIDALIS. Biol. Abstr. 4: 7373.

232 ARTIFICIAL REGENERATION

Sevcenko, S. V. 1961. VYRASCIVANIE OSOKORJA DLJA FANERNOGO PROIZVODSTVA. [GROWING POPULUS NIGRA FOR VENEER.] Lesn. Hoz. 14(11): 28-30. [Russ.]
Discusses the ecological requirements and rate of growth of burred forms of P. nigra in the Trans-Carpathian region, and also the possibilities of establishing plantations in order to increase the supply of burr material for furniture veneers.

232.1

Gerock. 1929. THE LOMBARDY POPLAR IN ALSACE. Biol. Abstr. 3: 3010.

Hermes. 1930. P. MONILIFERA IN GERMANY. Mitt. Dtsch. Dendrol. Ges. 42: 383.

Safar, J. 1962. PROBLEM PROIZVODNOSTI KULTURA CRNOG BORA U SUBMEDITERANSKOJ ZONI. [THE PROBLEM OF PRODUCTIVITY OF PINUS NIGRA VAR. AUSTRIACA PLANTATIONS IN THE SUBMEDITERRANEAN ZONE.] Sum. List 86(1/2): 32-40. [Croat.f.]

232.11

Cozzo, D. 1959. EL CRECIMIENTO DEL ALAMO NEGRO (POPULUS NIGRA CV. "ITALICA") EN ALTO VALLE DEL RIO COLORADO Y DEL RIO LIMAY, ARGENTINA. [GROWTH OF P. NIGRA VAR. ITALICA IN THE UPPER REACHES OF THE RIVERS COLORADO AND LIMAY, ARGENTINA.] Rev. For. Argent. 3(3): 88-100. [Span.]

232.13

Bugala, W., and Stecki, Z. 1961. MIESZANCE POPULUS MAXIMOWICZII HENRY I DOTYCHCZASOWE WYNIKIICH UPRAWY W KORNIKU. [P. MAXIMOWICZII HYBRIDS, AND RESULTS OF THEIR CULTIVATION IN KORNIK.] Arbor. Kornickie, Poznan 6: 93-116. 15 refs. [Pol.e.e. russ.]

Eschner, A. R. 1960. OBSERVATIONS ON A HYBRID POPLAR TEST PLANTING IN WEST VIRGINIA. U. S. For. Serv. Ntheast. For. Exp. Sta. Res. Note No. 111, 4 pp. 1 ref.
Of the 50 clones used on two sites (data on parentage and growth tabulated), 7 can be recommended for planting in a similar climate on soils of low pH in W. Virginia. All are hybrids of P. maximowiczii, and maintained an annual height increment of $\geq$ 3.6 ft. for 9 years on a well-drained site. The largest single tree was of clone NE-50 (P. maximowiczii $\times$ P. $\times$ berolinensis) with a height of 50 ft. and diameter of 6.1 in. after 9 growing seasons.

232.328

Gumpelmayer, E. 1949. DIE BEWURZELUNG VON STECKLINGEN UNTER DEM EINFLUSS VON HETEROAUXIN IN JAHRESRYTHMUS. [ROOTING OF CUTTINGS IN THE SEASONAL RHYTHM UNDER THE INFLUENCE OF HETEROAUXIN.] Phyton, Horn 1(2/4): 154-69. 30 refs. [G.g.]

232.328.1

Biolcev, A. 1956. KACESTVA NA LETORASTITE ZA REZNICI OT KANADSKA I PIRAMIDALNA TOPOLA V ZAVISIMOST OT GASTOTATA NA PENCETATE-MAJKI. [THE QUALITY OF SHOOTS FOR CUTTINGS OF POPULUS $\times$ 'CANADENSIS' AND P. NIGRA VAR. ITALICA IN RELATION TO THE SPACING OF THE PARENT STOOLS.] Nauc. Trud. Lesoteh. Inst., Sofia No. 4: 87-99. 4 refs. [Bulg.russ.]
The optimum stool spacing, for producing shoots 15-18 cm. long and 7-10 mm. thick, was 60-70 cm. for P. canadensis, and 50 cm. for P. nigra var. italica.

Ishizaki, A. 1951. [ROOTING AND GROWTH OF CUTTINGS OF DORONOKI (POPULUS MAXIMOWICZII HENRY) IN RELATION TO CUTTING MEDIA.] J. Jap. For. Soc. 33(10): 325-9. [Jap. jap.e.]
Rooting percent after 84 days was best on volcanic ash soil, then on peat and sand, peat and loam, loam, clay and sand, in that order. Greatest root growth occurred in peat and sand.

Kakesita. 1930. REGENERATION OF P. NIGRA BY STEM CUTTINGS. Bot. Cur. Lit. 12: 5.

Ogasawara, K. 1956. [STUDIES ON THE CUTTINGS OF FOREST TREES. (I). THE RELATIONSHIP BETWEEN THE ROOTING BEHAVIOUR AND THE REGION OF THE TREE FROM WHICH CUTTINGS WERE COLLECTED.] J. Jap. For. Soc. 38(8): 297-300. 8 refs. [Jap.jap.e.]

Shapiro, S. 1957. AUXIN CONTROL OF SEASONAL POLARIZATION OF ROOT EMERGENCE. Abstr. in Plant Physiol. 32(Suppl.): xlii.

Shidei, T., and Ogasawara, K. 1957. [STUDIES ON THE CUTTINGS OF FOREST TREES (II). THE EFFECT OF THE HORMONE TREATMENT ON THE ROOTING BEHAVIOUR OF THE CUTTINGS OF POPLAR (P. NIGRA VAR. ITALICA).] J. Jap. For. Soc. 39 (4): 124-7. 13 refs. [Jap. jap.e.e.]

———— and Ogasawara, K. 1957. [STUDIES ON THE CUTTINGS OF FOREST TREES (V). INFLUENCE OF AMOUNT OF LEAF, HORMONE

TREATMENT AND THEIR INTERACTION UPON THE ROOTING BEHAVIOUR OF POPLAR (POPULUS NIGRA VAR. ITALICA) CUTTINGS.] J. Jap. For. Soc. 39(8): 298-302. 4 refs. [Jap.jap.e.e.]

———— and Ogasawara, K. 1957. [STUDIES ON CUTTINGS OF FOREST TREES (VII). THE EFFECTS OF EXISTENCE OF BUDS AND HORMONE TREATMENT ON THE ROOTING BEHAVIOUR OF POPLAR (POPULUS NIGRA VAR. ITALICA) CUTTINGS.] J. Jap. For. Soc. 39(10): 389-92. 5 refs. [Jap.jap.e.e.]

Sonnenfeld, M. 1961. [THE BEST TIME FOR PROPAGATING SEVERAL TREES AND SHRUBS FROM CUTTINGS.] Acta Agrobotanica, Warsz. 10(2): 35-45. 4 refs. [Pol.pol.e.]

Tomza, B. 1959. WPLYW GRUBOSCI I DLUGOSCI ZRZEZOW TOPOLOWYCH NA WZROST SADZONEK W PIERWSZYM ROKU. [THE INFLUENCE OF DIAMETER AND LENGTH OF POPLAR CUTTINGS ON THE FIRST-YEAR INCREMENT.] Zesz. Nauk. Szkol. Gospod. Wiejsk. Warsz. (Lesn.) No. 2: 121-37. 16 refs. [Pol.g.russ.]

232.328.1/2

Floor, J. 1952. PROEVEN MET VERMEERDERING DOOR ENTSTEKKEN. [TRIALS OF PROPAGATING BY "× CUTTINGS" [CUTTINGS ASSISTED IN THE ROOTING PERIOD BY SIDE-GRAFTING TO CUTTINGS OF EASY ROOTERS].] Meded., Inst. Veredeling Tuinbouwgewassen, Wageningen No. 40, 26 pp. 11 refs. [Du.e.]

232.328.2

Hudson, J. P. 1955. PROPAGATION OF PLANTS BY ROOT CUTTINGS II. SEASONAL FLUCTUATION OF CAPACITY TO REGENERATE FROM ROOTS. J. Hort. Sci., Lond. 30 (4): 242-51. 13 refs. (Misc. Pub., Dep. Hort., Sutton Bonnington No. 9.)
Batches of cuttings were made at regular intervals over a period of a year, and cuttings from each batch planted in several different environments. The only woody species tested, Populus nigra, showed a seasonal variation in capacity to regenerate from root cuttings, this being greatest in winter.

232.43

Palotas, F. 1963. [DATA FOR MODERN TENDING OF POPLAR STANDS.] Erdo 12 (4): 150-5. 2 refs. [Hu.russ.g.]
Among controlling factors, the forester's most potent influence is through manipulation of stem number. Close- and open-stocking regimes of Populus × marilandica are compared in detail. The timing, interval and intensity of thinnings are delicate questions in these fast-growing stands. Close planting and subsequent regulation of stem number in consonance with the objects of management are advocated.

232.5

Costin, E. 1959. FIXAREA SI VALORIFICAREA DUNELOR NISIPOASE PRIN PROCEDEUL BUTASILOR PLANTATI ADINC. [THE FIXATION AND PRODUCTIVE USE OF SANDS BY DEEP PLANTING OF CUTTINGS.] Rev. Padurilor 74(1): 23-6. [Rum.russ.g.f.e.]
It was found that cuttings of Populus nigra var. the vestina 1.5 m. long, planted vertically so as to be completely covered by sand, gave 85.4% survival at the end of the second year when all other types of planting (both cuttings and seedlings, with and without the addition of humus) had failed completely.

233 AFFORESTATION

Babenko, D. K. 1957. ISPOL'ZOVANIE OSOKORJA NA TERSKO-KUMSKIH PESKAH. [THE USE OF POPULUS NIGRA ON THE TEREK-KUM SANDS.] Lesn. Hoz. 10(3): 28-30. [Russ.]
Tabulates data on height, diameter and volume increment of the poplar plantations, some of which are 42 years old, in the sandy areas to the west of the Caspian.

Lohr, T. 1951. ZUM THEMA: AUFFORSTUNG VON ANSCHUTTUNGSBODEN. [THE AFFORESTATION OF SPOIL MOUNDS.] Forst. u. Holz 6(19): 279-81. 14 refs. [G.]

235 UNDERPLANTING, ADVANCE PLANTINGS, ETC NURSES AND FORMATION OF MIXTURES

Borsos, Z. 1957. FAALLOMANY-SZERKEZETI VIZSGALATOK A VASI HEGYHATON. [STAND STRUCTURE INVESTIGATIONS IN THE HILLY REGION "HEGYHAT" OF VAS COUNTY.] Erdo 6(2): 41-51. [Hu.] From abstr. in Hung. Agric. Rev. 6(3): 1. 1957 [G.]
Recommends underplanting pure poplar stands (e.g. P. × marilandica) with hornbeam and regenerating them naturally. Oaks, if many in the upper story, should be reduced to allow entry of hornbeam, thus encouraging also the value and volume increment and natural regeneration of the oaks. Where valuable stems are few, they should be reserve-marked at the first thinning or else at 45-55 years.

237.4

Rigaud, A. 1952. UN BIOLOGISTE POITEVIN OBTIENT GRACE AUX BACTERIES DES RENDEMENTS RECORDS. [A POITEVIN BIOLOGIST OBTAINS RECORD CROPS, THANKS TO BACTERIA.] For. France No. 36: 11. [F.]

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Ernesto Alonzo, A. 1951/52. PROVISION DE MADERA PARA ENVASES - CULTIVO DEL ALAMO EN RIO NEGRO. [SUPPLYING TIMBER FOR PACKING CASES—IN THE CULTIVATION OF POPLAR IN THE RIO NEGRO TERRITORY.] Alm. Minist. Agric. Argent. 26/27: 169-74. [Span.]

Geschwind, G. 1955. ASVANYRARO KORNYEKI NYARASOK APOLASA. [TENDING OF POPLAR STANDS IN THE AREA OF ASVANYRARO.] Erdo 4(5): 191-6. [Hu.]
Describes large-scale plantings of Populus × marilandica begun in 1920 and now giving large intermediate and valuable final yields. Areas are clear-felled and planted with 2-m. saplings at 2×2 m. for final espacement of 5×5 or 6×6 m. at a rotation age of 25-30 years. Thinnings are made every 2-3 years. From abstr. in Hung. Agric. Rev. 4(3): 7. 1955.

242 THINNINGS

Koltay, G. 1955. A NYAR- ES EGYEB ALLOMANYOK APOLASA. [TENDING STANDS OF POPLAR AND OTHER SPECIES.] Erdesz. Kutatas. Budapest 1955(1): 3-16. [Hu.russ.e.g.]

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

378.44

Butyrskii, Ju. N. 1954. SPLAV LISTVENNOGO LESA BEZ HVOINOGO PODPLAVA. [FLOATING OF BROADLEAVED-SPECIES TIMBER WITHOUT CONIFEROUS FLOATS.] Lesn. Prom. 14(10): 29-30. [Russ.]
Populus nigra and Salix alba were floated in 1954 in large quantities on the Volga over a distance of ca. 1,500 km. without using softwood floats. The buoyancy of bundles made of these species is the greater the longer the logs, and the higher the proportion of large diameters, the basic condition being the presence of bar

4 FOREST INJURIES AND PROTECTION

Schwerin. 1902. CAUSES OF DYING OFF OF LOMBARDY POPLARS. Mitt. Dtsch. Dendrol. Ges. 11: 442.

416.13

Dunn, J. A. 1960. THE FORMATION OF GALLS BY SOME SPECIES OF PEMPHIGUS (HOMOPTERA: APHIDIDAE). Marcellia, Napoli 30 (Suppl., publ. in Strasbourg): 155-67. 7 refs. [E.e.]
Describes the method whereby the fundatrices of some Pemphigus species (P. bursarius, P. protospirae, P. spirothacae, P. filaginis, and P. phenax form their galls on Populus nigra var. italica.

Gomez-Menor Guerrero, J. M. 1957. BIOCENOSIS EN LAS AGALLAS DEL CHOPO. [BIOCOENOSIS IN POPLAR GALLS.] Graellsia, Madrid 15: 175-86. 19 refs. [Span.]
Presents notes on (1) Pemphigus spirotheca, producer of galls on leaves of Populus pyramidalis, and on three of its predators, and (2) Lepidosaphes ulmi and a parasite.

Kloft, W. 1960. BEOBACHTUNGEN ZUM ZEITLICHEN VERLAUF DES ABWURFS VERGALLTER UND NORMALER PAPPELBLATTER. [THE TIME-SEQUENCE OF LEAF SHEDDING OF NORMAL AND GALLED POPLAR LEAVES.] Marcellia, Napoli 30 (Suppl, publ. in Strasbourg): 125-6. 3 refs. [G.]
Leaves from under a Populus nigra var. italica were counted on an area of 2 sq. m. from 19 Oct. to 27 Oct. Of 370 leaves having Pemphigus bursarius galls, 213 dropped in the first, 141 in the second, and 16 in the last third of the period, whereas the sequence for healthy leaves was 203, 756, 450.

416.4/5

Maciejewska-Potapczykowa, W., and Niedzielski, A. 1962. ZAWARTOSC ZWIAZKOW AZOTU W TKANKACH ZDROWYCH I TUMORACH NIEKTORYCH ROSLIN. [N COMPOUNDS IN HEALTHY AND CANKERED TISSUE OF SOME PLANTS.] Acta Soc. Bot. Polon. 31(1): 95-101. 26 refs. [Pol.pol.e.e.]
The N fractions in cankered tissue of Datura stramonium, Populus nigra and Quercus robur were considerably higher than in healthy ones; but in crown gall tumors of oak, they were significantly lower than in the leaves. [From authors' summary.]

416.5

Rafes, P. M. 1955. ROL'OSINOVOJ STEKLJANNICY I TOPOLEVOJ PJATNISTOJ ZLATKI V GIBELI OSOKOREJ V ACIKULAKSKOM LESHOZE. [THE ROLE OF SCIAPTERON TABANIFORMIS AND MELANOPHILA PICTA IN THE MORTALITY OF POPULUS NIGRA ON THE ACHIKULAK LESKHOZ.] Soobsc. Inst. Les. No. 5: 84-95. 22 refs. [Russ.]
Observations in the steppe between the Terek and Kuma Rivers [Pre-Caspian lowland] indicated that the drop in the water table is the principal cause of the heavy poplar mortality.

———— 1956. ROL'OSINOVOJ STEKLJANNICY I TOPOLEVOJ PJATNISTOJ ZLATKI V GIBELI OSOKOREJ V ACIKULAKSKOM LESHOZE. [THE ROLE OF SCIAPTERON TABANIFORMIS AND MELANOPHILA PICTA IN POPULUS NIGRA MORTALITY ON THE ACHIKULAK LESKHOZ.] Soobsc. Inst. Les. No. 6: 62-78. 17 refs. [Russ.]
A second report giving further details on the degree of infestation and the type of injury to poplar stands in 1953 and 1954.

425.2

Karschon, R. 1962. [SEA WINDS AS SITE FACTORS.] Schweiz. Z. Forstw. 113(12): 687-91, 736. 3 refs. [G.f.]
Briefly discusses research in Israel on leaf necroses (accompanied by a great rise of Cl content in eucalypts and of Na in Populus nigra cv. 'Chile'), on soil effects, particularly under and, less so, to the lee of tree rows, and on windbreaks.

442.1

Kummerow, J., and Matte, V. 1960. ANATOMISCHE BEOBACHTUNGEN AN PHRYGILANTHUS TETRANDRUS (RUIZ ET PAV.) EICHL., EINER SEMIPARASITISCHEN LORANTHACEE. [ANATOMICAL STUDIES ON P. TETRANDRUS, A SEMI-PARASITIC MEMBER OF THE LORANTHACEAE.] Phytopath. Z. 39(4): 321-6. 7 refs. [G.g.span.]
Describes and illustrates with photomicrographs anatomical aspects of the attack by P. tetrandrus on Populus nigra var. italica.

443 FUNGI AND BACTERIA

Chorin, M. 1939. CYTOSPORA CHRYSOSPERMA ON POPULUS NIGRA. Palest. J. Bot., R. Ser. 2: 251-88. Rev. Appl. Mycol. 19: 171. 1940.

[Day, W. R.] 1948. [FROST INJURY AND BACTERIAL CANKER OF POPLAR.] Rep. Imp. For. Inst., Oxf. 1946-7: 12.

Minz, G. 1942. BEES GATHER RUST SPORES OF MELAMPSORA POPULINA KLEB. Hassadeh 22(6): 173. [Heb.] Rev. Appl. Mycol. 23: 366. 1944.

Truszkowska, W. 1957. OBSERWACJE NIEKTORYCH GRZYBOW PASOZYTNICZYCH I SAPROFITYCZNYCH NA PEDACH POPULUS EURAMERICANA MARILANDICA BOSC. W TURWI (WOJ. POZNANSKIE). [SOME PARASITIC AND SAPROPHYTIC FUNGI ON YOUNG P. × MARILANDICA AT TUREW NEAR POZNAN.] Acta Soc. Bot. Polon. 26(2): 257-69. 13 refs. [Pol.pol.f.]

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Castellani, E., and Cellerino, G. P. 1961. SU UNA ERYSIPHE PARASSITA DEL PIOPPO. [AN ERYSIPHE AS A PARASITE ON POPLARS.] Riv. Patologia Vegetale, Pavia (Ser. 3) 1(3): 298-304. 11 refs. [It.it.e.]

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Demetriades, S. D. 1950. LA ROUILLE DU PEUPLIER EN GRECE. [POPLAR RUST IN GREECE.] Ann. Inst. Phytopathologique Benaki, Athens 4(1/2): 50-2. 7 refs. [F.]
Records for the first time in Greece the occurrence of Melampsora allii-populina on Populus nigra.

Kesselhuth. 1953. DER PAPPELKREBS UND SEINE FOLGEN. [POPLAR CANKER AND ITS CONSEQUENCES.] Forst u. Holz 8(1): 2-4. [G.]
Describes an attack by Valsa sordida on 20-year-old Populus regenerata in Germany. P. robusta growing on the same site was unaffected.

Sinadskii, Ju. V., and Bondarceva, M. A. 1956. MALOIZVESTNYE TRUTOVIKI NA POPULUS I TAMARIX I IH ZNACENIE V KARA-KALPAKSKOI ASSR. [LITTLE KNOWN SPECIES OF INONOTUS ON POPLARS AND TAMARISK, AND THEIR SIGNIFICANCE IN THE KARA-KALPAK ASSR.] Bot. Z. 41(8): 1177-83. 3 refs. [Russ.]

Vlasov, A. A., and Krangauz, R. A. 1958. BOLEZNI BELOJ AKACII, DUBA I TOPOLJA V NASAZDENIJAH ACIKULAKSKOGC LESHOZA. [DISEASES OF ROBINIA PSEUDOACACIA, QUERCUS ROBUR AND POPULUS NIGRA IN STANDS IN THE ACHIKULAK LESKHOZ [CIS-CASPIAN LOWLAND].] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 35: 239-54. 1 ref. [Russ.]

451.2

Wuttky, K. 1959. UNGEWOHNLICHE MAUSESCHADEN AN PAPPELN. [UNUSUAL DAMAGE TO POPLARS BY MICE.] Forst u. Jagd 9(4): 184-5. [G.]
Describes and illustrates crown deformations in a 14-year stand of Populus × marilandica attributed to the feeding of mice which were observed to climb into the trees for safety during a severe flood when the poplars were 8 years old and 8 m. high. The species responsible were not ascertained.

453 INSECTS

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Sinadskij, Ju. V. 1961. O MOZOLEVIDNYH GALLAH NA TURANGE SIZOJ. [THE CALLUS-LIKE GALLS ON POPULUS PRUINOSA.] Ent. Obozr., Moskva 40(2): 297-9. [Russ.]
Describes the galls and their causal agent, Egeirotrioza sp., with notes on its biology.

5 FOREST MENSURATION

Dissescu, G. 1956. ATAC DE AGROMYZA CARBONARIA ZETT, PE POPULUS MARILANDICA. [ATTACK BY A. CARBONARIA ON P. × MARILANDICA.] Rev. Padurilor 1956(1): 59-60. 2 refs. [Rum.]
In thinning a 10-year-old sample plot of P. × marilandica, it was discovered that 10% of the trees removed were infested with A. carbonaria. The larval galleries, illustrated and described, were infected with bacteria producing a brown stain.

Qadri, M. A. H. 1951. A PRELIMINARY STUDY OF THE POPLAR LEAF BEETLE—NODOSTOMA SP. Pakistan J. For. 1(2): 119-21.
Life history, damage, etc., of the most important pest of Populus ciliata and P. nigra on the Murree hills. [A corrected reprint gives Phyllodecta abdominalis as the name of the beetle.]

52 MEASUREMENTS OF THE STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

Anonymous. 1917. MEASUREMENTS OF POPULUS MONILIFERA (P. SEROTINA). Quart. J. For. 11.

524.12

Armasescu, S., and Decei, I. 1954. CERCETARI ASUPRA COEFICIENTILOR DE FORMA AI ARBORILOR DE PLOP ALB SI PLOP NEGRU. [FORM FACTORS FOR TREES OF POPULUS ALBA AND P. NIGRA.] Bul. Sti. Acad. Repub. Rom. (Sect. (Sti.) Biol.) 6(2): 475-90. 6 refs. [Rum.russ.f.*russ.f.*]
The form factor (tree volume/cylindrical volume) does not vary between the two species, it varies in both with diameter as well as height, and is constant (0.427) for all trees of ≥ 50 cm. d.b.h. These conclusions are drawn from analysis of 404 black and 1,100 white poplars from different parts of Rumania.

Csiszar, I. 1955. FATOMEGTABLAK SZERKESZTESE. [[A STEP TOWARDS THE] CONSTRUCTION OF POPLAR VOLUME TABLES.] Erdesz. Kutatas., Budapest 1955(4): 15-29. 8 refs. [Hu.russ.e.g.]

524.315

Polycarpou, A. 1954. STANDARD VOLUME TABLES FOR POPULUS NIGRA L. "KAVAKI" IN CYPRUS. Tech. Pamphl. For. Dep. Cyprus No. 14, 1 p.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Dzekov, S. 1959. PRVI REZULTATI KOMPARATIVNOG GAJENJA KLONOVA P. ROBUSTA, P. REGENERATA I P. THEVESTINA NA PODRUCJU SKOPSKE KOTLINE. [PRELIMINARY RESULTS OF THE COMPARATIVE CULTIVATION OF CLONES OF POPULUS × ROBUSTA, P. × REGENERATA AND P. NIGRA VAR. THEVESTINA IN THE SKOPJE BASIN.] Topola, Beograd 3(11): 895-907. 4 refs. [Serb.g.g.]

Hausrat. 1896. NOTES ON GROWTH OF P. MONILIFERA. Forstwiss. Cbl. 40: 169-70.

Mutibaric, J. 1958. NEKI PODACI O PRIRASTU MLADE SASTOJINE POPULUS ROBUSTA, P. MARILANDICA I P. SEROTINA. [SOME DATA ON THE INCREMENT OF YOUNG STANDS OF P. × ROBUSTA, P. × MARILANDICA AND P. × SEROTINA.] Topola, Beograd No. 5: 384-95. 3 refs. [Serb.]

———— 1962. PRILOG POZNAVANJU PRIRASTA I ZAPREMINE DOMACIH CRNIH TOPOLA I VRBE. [INCREMENT AND VOLUME OF NATIVE BLACK POPLAR AND WILLOW.] Sumarstvo 15(1/2): 39-46. 3 refs. [Serb.f.]
Gives details of d.b.h., height, volume, etc., from natural stands of black poplar averaging 36 years and willow averaging 37 on the Danube plain near Sombor, N. Vojvodina.

561.21

Popescu-Zeletin, I., and Mocanu, V. G. 1962. L'ACCROISSEMENT RADIAL DES PEUPLEMENTS PENDANT LA PERIODE DE VEGETATION. [RADIAL INCREMENT OF STANDS DURING THE GROWING SEASON.] Proc. 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2(2), Sect. 25/11-S/7, 13 pp. 7 refs. [F.]

561.3

Anonymous. 1932. GROWTH FORM OF P. LASIOCARPE. Mitt. Dtsch. Dendrol. Ges. 44: 386.

562.2

Anonymous. 1915. GROWTH AND YIELD OF BLACK POPLAR (P. NIGRA). Abstr. of Italian article. Int. Inst. Agric. Mon. Bull. (S.R.E.) 12: 1656.

Petrescu, L., and Disescu, R. 1955. PRODUCTIA SI CRESTE RILE CELUI MAI IN VIRSTA ARBORET DE PLOPI NEGRI HIBRIZI DIN TARA. [THE AGE OF MAXIMUM YIELD AND INCREMENT FOR HYBRID BLACK POPLARS IN RUMANIA.] Rev. Padurilor 70(3): 101-5. 5 refs. [Rum.]
Data are given and discussed for increment of a plantation of × Populus marilandica, measured at 14, 19, 24, and 32 years. C.a.i. culminated at 22, and m.a.i. at 25 years; the latter age is recommended for exploitation.

Somma. 1916. GROWTH OF BLACK POPLAR IN TUSCAY. (Abstr.) Int. Inst. Agric. Mon. Bull. (S.R.E.) 1: 92.

566 YIELD TABLES AND THEIR CONSTRUCTION

Hilf, H. H., and Schmitz-Lenders, B. 1962. [INCREMENT AND YIELD OF THE 'HARFF' POPLAR [POPULUS × 'REGENERATA'].] Forstarchiv 33(8): 166-70. 3 refs. [G.]

Matsui, Z., Moori, K., and Sasaki, M. 1955. [THE SOCIATING AND GROWING OF NATURAL STANDS ON THE BOTTOMLAND IN THE TESHIKAGA REGION.] Spec. Rep. For. Exp. Sta., Hokkaido No. 3: 154-61. 5 refs. [Jap.e.]
Stands of Doro-poplar (Populus maximowiczii), four kinds of willow, elm, ash, and alder aged ca. 31 years carry volumes of 225-249 cu.m./ha. Regressions are given for height and diameter and number of stems/ha. in the main crop on age. A m.a.i. of 7 cu.m./ha. can be expected. A yield table is included.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Klauditz, W. 1951. UBER DIE MECHANISCHEN EIGENSCHAFTEN UND CHEMISCHE ZUSAMMENSETZUNG DES STAMMHOLZES ZWEIER PAPPELHYBRIDEN. [MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION OF THE STEM WOOD OF TWO POPLAR HYBRIDS.] Holz Roh- u. Werkstoff 9(5): 81-4. 11 refs. [G.g.]

810 GENERAL INFORMATION ON WOOD

[Japan: Wood Ind.] 1957. [JAPANESE WOODS: POPULUS MAXIMOWICZII.] Suppl. to Wood Ind., Tokyo 12(6). 2 pp. [Jap.]
Includes three photomicrographs and data on physical and mechanical properties.

Sachsse, H. 1961. BEITRAG ZUR KENNTNIS DER HOLZEIGENSCHAFTEN DER OXFORD-PAPPEL. [THE WOOD PROPERTIES OF THE 'OXFORD' POPLAR.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No 11: 92-102. 25 refs. [G.g.]

811.12

Necesany, V. 1959. A NOTE ON THE STRUCTURE OF MICROFIBRII IN NATIVE CELL WALLS. Svensk PappTidn. 62(3): 73-6. 11 ref [E.e.sw.g.]

811.22

Rosso, R. 1958(1959). OSSERVAZIONI SULLA DIFFERAZIONE D LEGNO DI TENSIONE IN PIANTE DI PIOPPO NERO. [THE DIFFERENTI TION OF TENSION WOOD IN BLACK POPLAR.] Nuovo G. Bot. It (n.s.): 65 (3): 592-9. 5 refs. [It.it.e.]
The author studied the differentiation of tension wood from t cambium in artificially bent branches of a young tree of Popu

nigra, and describes the different stages of anatomical development with illustrations from photomicrographs.

Sachsse, H. 1962. [ELECTRON-MICROSCOPE INVESTIGATIONS ON THE CELL-WALL STRUCTURE OF TENSION-WOOD FIBERS.] Holz Roh- u. Werkstoff 20(11): 429-33. 21 refs. [G.g.e.]

812 PHYSICAL AND MECHANICAL PROPERTIES

Horvat, I. 1960. PRILOG POZNAVANJU NEKIH FIZICKIH I MEHANICKIH SVOJSTSVA BIJELE I CRNE TOPOLOVINE (POPULUS ALBA L., POPULUS NIGRA L.). [SOME PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF P. ALBA AND P. NIGRA.] Sum. List 84(3/4): 95-115. 12 refs. [Croat.croat.e.]

Lenz, O. 1956. LEBOIS DES PRINCIPAUX PEUPLIERS ET D'UN SAULE INDIGENES EN SUISSE. [THE WOOD OF THE CHIEF POPLARS AND OF A WILLOW NATIVE TO SWITZERLAND.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 32(5): 203-27. 12 refs. [F.f.g.it.e.]

Michalak, J., Rogalinski, K., and Kubiak, M. 1963. [TESTS ON THE TECHNICAL PROPERTIES OF POPULUS × MARILANDICA WOOD.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 17: 219-32. 32 refs. [Pol.e.]
Tabulates results of detailed studies of the chemical, physical, and mechanical properties of Polish-grown wood. [Cf. Kubiak, Rogalinski, and Michalak, 1962, P. lasiocarpa to P. nigra and vars., 844.2.]

Stojanov, V., and Encev, E. 1959. POPULUS PRZEWALSKII UND IHR HOLZ. [P. PRZEWALSKII AND ITS WOOD.] C.R. Acad. Bulg. Sci. 12(6): 569-72. 1 ref. [G.russ.]

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Hirai, S., Tsuchiya, K., and Aida, T. 1962. [MECHANICAL PROPERTIES OF THE WOODS OF POPULUS SPP. OF THE TOKYO UNIVERSITY FOREST IN HOKKAIDO.] Misc. Inform. Tokyo Univ. For. No. 14: 63-71. 16 refs. [Jap.]
Presents tabulated results of standard tests on P. tremula var. davidiana (separately for green-, orange-, and grey-barked forms) and P. maximowiczii, from trees 28-40 years old; also for 22 Japanese, Manchurian, or Korean provenances of P. maximowiczii.

Venet, J. 1955. ESSAIS SUR LA RESISTANCE MECANIQUE DU BOIS DE PEUPLIER FAITS AU LABORATOIRE DE TECHNOLOGIE DE L'ECOLE NATIONALE DES EAUX ET FORETS. [TESTS OF THE MECHANICAL STRENGTH OF POPLAR WOOD MADE AT THE ECOLE DES EAUX ET FORETS, NANCY.] Annexe to [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-B: 9-12. [F.]
Gives the results of tests on P. deltoides ("carolinensis"), × P. regenerata, and P. tremula.

813 WOOD CHEMISTRY

Prosinski, S. 1954. ZBADAN NAD WYODREBNIANIEM MASY CELULOZOWEJ Z DREWNA TOPOLI CZARNEJ I BIALEJ. [INVESTIGATIONS ON THE PULPING OF POPULUS NIGRA AND P. ALBA.] Sylwan 98(3): 229-38. 19 refs. [Pol.pol.]

813.1

Babicki, R. 1960. ZAWARTOSC CELULOZY I LIGNINY W DREWNIE × POPULUS MARILANDICA. [THE CELLULOSE AND LIGNIN CONTENTS OF P. × MARILANDICA WOOD.] Sylwan 104(9): 100-6. 5 refs. [Pol.]

Simionescu, C. 1958. CONSIDERATIONS ON SOME RESULTS OBTAINED IN THE STUDY OF VEGETABLE CANCER. Bul. Inst. Politehnic din Iasi (n.s.) 4(3/4): 204-16. 13 refs. [E.russ.rum.]
The author summarizes work already published on chemical changes in the wood of cankers occurring on pine and beech, and presents and discusses data from a similar study of an elm tumor and a poplar (Populus nigra). The results confirm previous findings that in cankered wood there is an increase in lignin and a corresponding decrease in cellulose, the sum of lignin and cellulose remaining constant at 70.51-74.83 percent.

813.11

Nakano, J., Ishizu, A., and Migita, N. 1961. STUDIES ON LIGNIN. XXXII. ESTER GROUPS OF LIGNIN. Tappi 44(1): 30-2. 7 refs.

Sakakibara, A., and Nakayama, N. 1961. HYDROLYSIS OF LIGNIN WITH DIOXANE AND WATER. I. FORMATION OF CINNAMIC ALCOHOLS AND ALDEHYDES. J. Jap. Wood Res. Soc. 7(1): 13-8. 11 refs. [E.e.jap.]
Data on hydrolysis products from Picea jezoensis, Gafus crenata, and Populus nigra wood meal.

813.14

Anderson, E., Kaster, R. B., and Seeley, M. G. 1942. HEMICELLULOSES AND PECTIC MATERIALS FROM COTTONWOOD, POPULUS MACDOUGALI. J. Biol. Chem. 144(3): 767-72. Bblg.

814.1

Wechel, A. Te. 1943. OVER DE DUURZAAMHEID VAN HET HOUT VAN DEN DOUGLASSPAR, DE SITKASPAR EN DEN JAPANSCHEN LARIKS. [ON THE NATURAL DURABILITY OF WOOD OF DOUGLAS FIR, SITKA SPRUCE AND JAPANESE LARCH.] Ned. Boschb.-Tijdschr. 16(11): 444-5. [Du.]

826.1

Nakamura, G., and Saito, M. 1960. [STUDIES ON ROTARY LATHE CUTTING. REPORT (III) EFFECT OF CUTTING CONDITIONS ON THE QUALITY OF BASSWOOD, ASPEN AND TULIP TREE VENEER.] Bull. For. Exp. Sta., Meguro, Tokyo No. 119: 67-78. 10 refs. [Jap.jap.e.e.]
Describes tests on Tilia japonica, Populus maximowiczii, and Liriodendron tulipifera.

832.20

[U.K.: For. Prod. Res. Lab.] 1953. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PROGRESS REPORT 18. CONSIGNMENT NO. 760. SPECIAL TESTS. BLACK POPLAR (POPULUS NIGRA) HOME GROWN. For. Prod. Res. Lab., Princes Risborough. 14 pp.
Tests to determine the effect of the knife and pressure-bar positions on the woolly appearance of poplar veneer.

841.41

Meyer, K. 1954. ZUM HOLZSCHUTZ UND SEINER DURCHFUHRUNG BEIM TECHNISCH VERWENDETEN PAPPELHOLZ. [WOOD PRESERVATION METHODS FOR POPLAR WOOD IN INDUSTRIAL USE.] Abstr. in Forsch. u. Berat. (Forstw.) Landesaussch. Landw. Forsch. Landes Nordrhein-Westfalen No. 1: 136-7. [G.]

844.2

Kubiak, M., Rogalinski, K., and Michalak, J. 1962. [CHANGES IN THE PHYSICAL AND MECHANICAL PROPERTIES OF POPULUS × MARILANDICA UNDER THE INFLUENCE OF PORIA VAPORARIA.] Sylwan 106 (3): 25-39. 26 refs. [Pol.russ.e.]
Tabulates and graphs data on the effect of pure cultures of the fungus on the properties of P. × marilandica specimens exposed to them for various periods. The fungus caused rapid deterioration—4 months' exposure rendered the wood useless.

———— Rogalinski, K., and Michalak, J. 1962. CHANGES IN PHYSICAL AND MECHANICAL PROPERTIES OF POPLAR WOOD (POPULUS MARILANDICA BOSC.) INDUCED BY THE FUNGUS PORIA VAPORARIA (PERS./FR.). Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 6229, 20 pp. 1963. 26 refs.
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Schultze-Dewitz, G. 1957. VERSCHIEDENARTIGE TERMITENANGRIFFE AN PAPPEL- UND DOUGLASIENHOLZ. [SPECIFIC DIFFERENCES IN TERMITE ATTACK ON POPLAR AND DOUGLAS FIR WOOD.] Arch. Forstw. 6(11/12): 933-41. 8 refs. [G.g.russ.e.]

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Migita, N. 1939. PULPWOODS AND PULPS. II. MANUFACTURE OF PULPS FROM MANCHURIAN SPRUCE, FIR, AND ASPEN (PICEA OBOVATA, ABIES NEPHEROLOPIS, AND POPULUS MAXIMOWICZII). Cellulose Ind., Tokyo 15: 54-8. Chem. Abstr. 34: 2591.

861.0

Prosinski, S. 1954. ZBADAN NAD WYODREBNIANIEM MASY CELULOZOWEJ Z DREWNA TOPOLI CZARNEJ I BIALEJ. [INVESTIGATIONS ON THE PULPING OF POPULUS NIGRA AND P. ALBA.] Sylwan 98(3): 229-38. 19 refs. [Pol.pol.]

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Sarraillet, J. M. 1947(1949). CARBONES ACTIVOS DE ALAMO, SAUCE Y CEIBO. [ACTIVATED CARBON FROM POPULUS NIGRA VAR. ITALICA, SALIX BABYLONICA AND ERYTHRINA CRISTA-GALLI.] Revista de la Facultad de Ciencias Quimicas, Universidad Nacional de la Plata No. 22: 91-109. 5 refs. [Span.]

892.1

Folgado, J. dos S. C. 1959. DIGESTIBILIDADE E VALOR ALIMENTAR DAS FOLHAS DO ULMEIRO E CHOUPO. [DIGESTIBILITY AND FODDER VALUE OF ELM AND POPLAR LEAVES.] Estud. Inform. Serv. Flor. Aquic. Portugal No. 104-G3, 16 pp. 20 refs. [Port.e.]

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

907.1

Arnold. 1928. LOMBARDY POPLAR AS AMENITY TREE IN UTAH. Amer. For. 34: 491.

P. ROBUSTA TO P. SUKASHEWI

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

161.16

Jovanovic, M. 1962. [MEASUREMENT OF INTENSITY OF TRANSPIRATION IN SOME BROADLEAVED SPECIES (POPLAR, OAK, BEECH).] Topola, Beograd 6(27): 18-9. 5 refs. [Serb.f.]
Transpiration was measured on detached leaves by weighing in an electric balance immediately after detaching and after 45 minutes. Results are given in g. of water transpired/sq.m. leaf area/hr. Transpiration in Populus × serotina was 2-3 times as great as in Quercus robur or Fagus sylvatica.

165.71

Joachim, H. F. 1958. UBER DIE SPREEWALD-PAPPEL. [THE 'SPREEWALD' POPLAR.] Silvae Genet. 7(1): 25-30. 8 refs. [G.g.e.f.]

Jovanovic, B., and Tucovic, A. 1959. ZAPAZANJA O DEJSTVU JONIZUJUCEG ZRACENJA NA SEME I PRIRAST POPULUS VIRGINIANA FOUG. PRETHODNO SAOPSTENJE. [THE EFFECT OF IONIZING RADITION ON SEEDS AND [SEEDLING] GROWTH OF P. DELTOIDES [× P. SEROTINA]. PRELIMINARY REPORT.] Sumarstvo 12(9/10): 451-62. 7 refs. [Serb.f.f.]

Jovanovic, S. 1957. PRIRODNA HIBRIDIZAOIJA IZMEDU TOPOLA × P. MARILANDICA I × P. SEROTINA. [NATURAL HYBRIDIZATION BETWEEN POPULUS × MARILANDICA AND P. × SEROTINA.] Topola, Beograd No. 4: 294-7. [Serb.]
Records a case in Yugoslavia of presumed natural fertilization of P. × marilandica by P. × serotina (no other male trees existed within a radius of 4-5 km.), and recommends planting these varieties in mixture to form a source of hybrid seed for progeny trials.

165.72

Kobendza, R. 1953. CZYM JEST TOPOLA ROGALINSKA? [WHAT IS POPULUS ROGALINENSIS?] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 9: 153-66. 3 refs. [Pol.russ.e.]

Scepotjev, F. L. 1954. NOVYE GIBRIDNYE FORMY OSINY. [NEW HYBRID FORMS OF ASPEN.] Dokl. Akad. Nauk SSSR 97(1): 161-4. 2 refs. [Russ.]

165.72/73

Bogdanov, P. L. 1958. NOVYE GIBRIDY TOPOLEJ. [NEW POPLAR HYBRIDS.] Lesn. Hoz. 11(3): 85-6. [Russ.]
Brief notes on Populus suaveolens × P. 'canadensis'—the "Leningrad poplar," and a "vegetative hybrid" taken from buds at the graft union of P. suaveolens and P. 'canadensis'. Both are said to be fast-growing, and resistant to cold, and the "vegetative hybrid" is not susceptible to leaf rust.

176.1

Anonymous. 1912. POPULUS SEROTINA. Quart. J. For. 6: 263.

———— 1929. NOTE ON P. ROBUSTA. Dtsch. Forstw. 11: 63.

Grossheim, A. A. 1944. NOVY PIRAMIDALY TOPOL'. [A NEW PYRAMIDICAL POPLAR.] Bot. Zhurn. SSSR 29(4): 124-5. [Russ.]

Joachim, H. F. 1958. UBER DIE SPREEWALD-PAPPEL. [THE 'SPREEWALD' POPLAR.] Silvae Genet. 7(1): 25-30. 8 refs. [G.g.e.f.]

Kobendza, R. 1953. CZYM JEST TOPOLA ROGALINSKA? [WHAT IS POPULUS ROGALINENSIS?] Roczn. Dendrol. Polsk. Tow, Bot., Warsz. 9: 153-66. 3 refs. [Pol.russ.e.]

Rubtsov, N. I. 1946. TYAN'SHANSKAYA OSINA. [THE TIAN-SHAN ASPEN.] Sovetsk. Bot. 14(5): 333-4. Bblg. [Russ.]

Starikov, G. F. 1960. CENNAJA PORODA SEVERA. [POPULUS SUAVEOLENS—A VALUABLE SPECIES IN THE NORTH OF THE U.S.S.R.] Priroda, Moskva 49(4): 104-5. [Russ.]
A brief general account covering, inter alia, distribution, stand volume, and height.

Vill. 1927. P. ROBUSTA, SCHNEID. Mitt. Dtsch. Dendrol. Ges. 38: 259.

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Read, R. A. 1958. SILVICAL CHARACTERISTICS OF PLAINS COTTONWOOD [POPULUS SARGENTII]. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta., Sta. Pap. No. 33, 18 pp. 25 refs.

Wijkstrom, S. 1947. POPPELN SOM SKOGSTRAD. [POPLAR AS A FOREST TREE.] Skogen 34(20): 267-8. [Sw.]

181.21

Sebald, O. 1958. UBER DIE LICHTANSPRUCHE DER PAPPELSORTEN. [LIGHT REQUIREMENTS OF POPLAR VARIETIES.] Holzzucht, Reinbek 12(2): 13. 2 refs. [G.]
Includes a note on trials with Populus trichocarpa and the 'Rochester' poplar (P. trichocarpa × P. nigra) which showed themselves more tolerant to shade when planted in narrow gaps, narrow gulleys or in close spacing, than black poplar hybrids.

181.34

Demortier, G., Riga, A., Darcheville, M., and others. 1954. LE DEVELOPPMENT DES BOUTURES DE POPULUS ROBUSTA SCHNEID. EN FONCTION DU PH ET DU RAPPORT CA/MG. [THE GROWTH OF POPLAR CUTTINGS AS A FUNCTION OF PH AND CA/MG RATIO.] Bul. Inst. Agron. Gembloux 22(1/2): 10-7. [F.f.]

Fritzsche, K., and Kemmer, C. 1959. UBER DEN EINFLUSS VON KALK AUF WACHSTUM UND ENTWICKLUNG VON PAPPELSTECKLINGEN UNTER BESONDERER BERUCKSICHTIGUNG DES PH WERTES. [THE EFFECT OF CA ON GROWTH AND DEVELOPMENT OF POPLAR CUTTINGS, WITH SPECIAL REFERENCE TO PH.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 40 (Beitr. Pappelforsch. III): 135-69. 27 refs. [G.g. russ.e.]

181.341

Meiden, H. A. van der. 1959. HET ONDERZOEK NAAR DE BETEKENIS VAN KALIUM VOOR DE POPULIER. [STUDIES ON THE IMPORTANCE OF K TO POPLARS.] Kali, Amsterdam 4(40): 371-6. 3 refs. [Du.] *A study of deficiency symptoms in poplar leaves suggests that lack of K can only be determined by leaf analysis, less than 1% K in the leaves indicating deficiency. Analysis of leaves of Populus × robusta from various areas where rust was present showed that there tended to be an inverse relation between severity of attack and contents of K.*

181.4

Fransen, J. J. 1947. AANWASVERLIESEN ALS GEVOLG VAN KAALVRETERIJ BIJ POPULUS SEROTINA HART. EN POPULUS MARILANDICA BOSC. [LOSS OF INCREMENT IN P. SEROTINA AND P. MARILANDICA AS A RESULT OF DEFOLIATION.] "Mededeelingen" van den Directeur van den Tuinbouw April 1947: 216-32. 7 refs. [Du.e.]
[*See report on same subject by Fransen, J. J., and Houtzagers, G., in Ned. Boschb.-Tijdschr. 18(2): 36-9. 1946. F.A. 9, No. 608.*]

182.1

Inokuma, T. 1960. FOSSIL, POPULUS SIEBOLDII FOUND IN SHIOBARA PLEISTOCENE BED, JAPAN. Poplars, Japan 9: 8. [Jap.] From abstr. in Rec. Res. Fac. Agric. Univ. Tokyo No. 11: 105. 1962. [E.] *The morphology of a fossilized leaf found in this famous Pleistocene bed coincided exactly with that of a present-day sample of P. sieboldii. This is the first record of the species in Japanese fossilized flora.*

2 SILVICULTURE

226 CHANGES OF SILVICULTURAL SYSTEM. CONVERSION (BY SYSTEM OR SPECIES)

Glavac, V. 1962. [INCREASING WOOD PRODUCTION BY INTRODUCING EURAMERICAN POPLARS INTO CERTAIN TYPES OF ALNUS GLUTINOSA COPPICE.] Sum. List 86(11/12): 415-24. 6 refs. [Serb.g.] *Presents data for both species on the height, number of stems, b.a./acre, volume, and soil conditions in three 20- to 22-year poplar/alder stands, in a Pruno-Fraxinetum area, where the growing stock of alder coppice has been greatly increased by the introduction of Populus × serotina.*

231.4/5

Mutibaric, J. 1955. PRIRODNO PODMLADIVANJE KANADSKE TOPOLE. [NATURAL REGENERATION OF POPULUS "CANADENSIS".] Sumarstvo 8(5): 266-72. 2 refs. [Serb.e.f.]

231.5

Bajin, I. 1956. PRIRODNO PODMLADJIVANJE KAWADSKE TOPOLE. [NATURAL REGENERATION OF POPULUS SEROTINA.] Sumarstvo 9 (1/2): 89-90. 1 ref. [Serb.] *Cites several examples of its regeneration by root-suckering in Yugoslavia. No general conclusions can be drawn as suckering will be influenced by site conditions and each stand must be considered separately.*

232 ARTIFICIAL REGENERATION

Witkowski, L. 1937. TOPOLA KANADIJSKA W WISLKOPOLSOE I JEJ HODOWLA ZRZEZOW ORAZ NASION. [BLACK ITALIAN POPLARS IN THE POZNAN DISTRICT, THEIR PROPAGATION BY CUTTINGS AND SEED.] Roczn. Nauk Rol. 41: 301-5. [Pol.g.]

232.1

Anonymous. 1926. P. ROBUSTA, REPUTED TO BE THE FASTEST GROWING POPLAR. Mitt. Dtsch. Dendrol. Ges. 37: 327.

Korczak. 1928. P. ROBUSTA IN POLAND. Forstl. Rundschau 1: 366.

232.13

Baldwin, H. I., and Funking, D. L. 1954. TWENTY YEARS' GROWTH OF HYBRID POPLARS. Fox For. Note No. 56, 2 pp. *A further report on Stout and Schreiner hybrids, planted in 1935 as unrooted cuttings. The first 6 years' growth was reported in an earlier note [cf. Baldwin, 1941, Populus sp., 232.13. Growth was in the following descending order of clones: Geneva, Oxford, Androscoggin, Rochester, Strathglass.*

Bialobok, S., and Bugala, W. 1951. PRZEGLAD PRAC HODOWLANYCH NAD TOPOLAMI I WYNIKI DOTYCHCZASOWYCH OBSERWACYJ PRZEPROWADZONYCH NAD NIEKTORYMI MIESZANCAMI TOPOLI W KORNIKU. [SURVEY OF STUDIES ON POPLAR GROWING AND RESULTS OF AVAILABLE OBSERVATIONS ON SOME POPLAR HYBRIDS AT KORNIK.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 7: 130-58. 13 refs. [Pol.pol.e.]

232.322.412

Meiden, H. A. van der. 1957. REACTIE VAN POPULIERENSTEK OP FOSFAAT (EEN ORIENTERENDE PROEF). [REACTION OF POPLAR CUTTINGS TO PHOSPHATE (A PRELIMINARY EXPERIMENT.] Ned. Boschb.-Tijdschr. 29(10): 229-42. [Du.du.e.]

232.324.3

Gunther, H. 1958. WIRKUNG DER VERBANDSWEITEN AUF DIE ERZIEHUNG VON PAPPELPFLANZEN. [THE EFFECT OF SPACING ON POPLAR PLANTS IN THE NURSERY.] Forst u. Jagd 8(1): 10-5. [G.]

232.328.1

Reinders-Gouwentak, C. A. 1953. PROBLEMS IN VEGETATIVE PROPAGATION OF POPULUS. Proc. Ned. Akad. Wet. 56 C(2): 202-5. 6 refs. [E.e.] *Further experiments with P. robusta confirm the better rooting obtained from cuttings kept for 14 days in darkness and then given long-day treatment.*

———— and Sipkens, J. 1953. THE INFLUENCE OF PHOTOPERIOD, DORMANCY BREAKING AND GROWTH HORMONE TREATMENT ON POPLAR CUTTINGS. Proc. Ned. Akad. Wet 56 C(1): 71-80. 6 refs. [E.e.]

232.328.9

Haissig, B. E. 1963. SEASONAL VARIATION IN ROOT AND SHOOT FORMATION FROM LEAF CUTTINGS OF POPULUS SIMONII VAR. FASTIGIATA SCHNEID. Silvae Genet. 12(1): 31-5. 21 refs. [E.e.g.f.]

232.4

Badoux, E. 1942. LES CULTURES DE PEUPLIER DU FORT (CANTON DE VAUD). [THE POPLAR PLANTATIONS OF LE FORT (CANTON OF VAUD).] J. For. Suisse 93(2): 33-9. Bblg. [F.]

Lallemand. 1945. LES PLANTATIONS DE PEUPLIERS EN CHAUTAGNE. [THE POPLAR PLANTATIONS IN CHAUTAGNE.] Bull. Soc. For. Franche-Comte 25(8): 316-22. [F.]

232.43

Becking, J. H. 1958. HET PLANTVERBAND VOOR POPULIEREN- OPSTANDEN. [PLANT SPACING IN POPLAR STANDS.] Ned. Boschb.-Tijdschr. 30(8): 241-3. [Du.]

[Germany: Forst u. Jagd] 1960. FLURHOLZANBAU IN DER DDR. [GROWING WOODY SPECIES OUTSIDE THE FOREST IN EAST GERMANY.] Forst u. Jagd Spec. No., 48 pp. 62 refs. [G.]

Szodfridt, I. 1960. TOLNASZIGETI KESEINYAR HALOZATKISERLET. [A SPACING TRIAL WITH POPULUS × SEROTINA IN TOLNASZIGET.] Erdo 9(7): 247-51. [Hu.russ.g.] *Trials at 2×2, 4×4, 6×6, and 8×8 m. showed (at the 10th year in local conditions) 2 × 2 to yield greatest volume, and 4 × 4 the greatest value. Where hand labor is used, 2 × 2 thinned to 4 × 4 m. in the 3rd or 4th year is recommended; for mechanical cultivation, planting at 3 × 1.5 m.*

Vries, P. G. de. 1961. PRODUCTIE EN STAMVORM BIJ VERSCHILLEND PLANTVERBAND IN DE POPULIERENOPSTAND BIJ EMMELOORD, N.O. POLDER. [YIELD AND STEM FORM OF POPLAR GROWN AT DIFFERENT SPACINGS IN A STAND NEAR EMMELOORD, N.E. POLDER.] Ned. Boschb.-Tijdschr. 33(12): 347-53. [Du.du.e.]

232.5

Rohmeder, E. 1961. PAPPELBESTANDSBEGRUNDUNG IN ENGEN VERBANDEN MIT STECKLINGEN. [ESTABLISHING POPLAR STANDS WITH CUTTINGS AT CLOSE SPACINGS.] Allg. Forstzeitschr. 16(31): 449-52. 4 refs. [G.g.]

233 AFFORESTATION

Evans, W. D. D. 1952. AFFORESTATION OF WASTELAND. J. Land Agents' Soc. 51(1): 43-4.

Describes the successful afforestation of spoil from sand and gravel works with Sitka spruce and unrooted cuttings of Populus robusta.

Fritzsche, K., and Kemmer, C. 1961. BEITRAG ZUR FRAGE DER PAPPELDUNGUNG AUF DILUVIALEN KIPPENSANDEN DER NIEDERLAUSITZ. [FERTILIZING OF POPLARS ON DILUVIAL SPOIL-MOUND SANDS IN THE NIEDERLAUSITZ [E. GERMANY].] Wiss. Abh. Dtsch. Akad. Landw-Wiss., Berlin No. 52 (Beitr. Pappelforsch. No. 6): 7-21. 13 refs. [G.g.russ.e.]

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Milovanovic, M. 1956. NEKA ZAPAZANJA I PODACI V MLADIM TOPOLOVIM KULTURAMA. [OBSERVATIONS AND DATA ON YOUNG POPLAR PLANTATIONS.] Sumarstvo 9(1/2): 15-26. [Serb.e.f.]

4 FOREST INJURIES AND PROTECTION

416.11

Joly, R. 1959. INFLUENCE DES DEFOLIATEURS FORESTIERS SUR L'ACCROISSEMENT. [THE INFLUENCE OF FOREST DEFOLIATORS ON INCREMENT.] Rev. For. Franc. 11(11): 775-84. [F.]

416.16

Pourtet, J. 1958. LE DEPERISSEMENT DES PEUPLIERS DANS LE NORD-EST DE LA FRANCE AU PRINTEMPS 1958. [THE DIE-BACK OF POPLARS IN N.E. FRANCE IN SPRING 1958.] Rev. For. Franc. 10 (8/9): 521-5. [F.]
The severe die-back described was found to be mainly in Populus × robusta plantations more than 20 years old, in regions with a predominantly continental climate, and situated in valley bottoms. It is ascribed to the severe frosts of Feb. 1956 followed by unfavorable conditions (mild winters with late frosts) in 1957 and 1958.

———— 1961. A PROPOS DU DEPERISSEMENT "CLIMATIQUE" DES PEUPLIERS. [THE "CLIMATIC" DIE-BACK OF POPLARS.] Rev. For. Franc. 13(1): 31-4. [F.]
Further examination of Populus × robusta plantations affected by the severe frosts of 1956 followed by mild winters and late frosts in 1957 and 1958 showed 3 types of reaction: (1) irreversible dieback in old or sickly trees; (2) a sharp reduction in increment and striking, but reparable, die-back in young (15-20 years) trees on good sites; (3) reduction in increment with no visible signs of ill health in quite young (10 years) and vigorous trees.

424.7

Benzian, B., and Warren, R. G. 1957. COPPER DEFICIENCY IN POPLAR CUTTINGS. Rep. Rothamst. Exp. Sta. 1956: 57-8.
In 1955 "needle-tip-burn" on Sitka spruce seedlings grown at Wareham was shown to be due to Cu deficiency. The black discoloration of the leaves of Populus robusta cuttings grown on the same soil has now been diagnosed as a deficiency on the same micronutrient. Symptoms were greatly reduced by a soil application of a fritted trace-element material containing Fe, Mn, Cu, Zn, Mo, and B, and by foliar sprays of Cu applied as a lime/$CuSO_4$ mixture.

Kannenberg, H. 1963. [CAN POPULUS "ROBUSTA" SUFFER FROM CU DEFICIENCY?] Holzzucht, Reinbek 17(1/2): 14. [G.]
In two series of open-air pot trials in a sandy soil with high humus and little Cu content (2.1 or 0.8 p.p.m.) plus an N/P/K fertilizer, the addition of 7.5 kg. Cu/ha. greatly increased height growth and improved habit over the excessively bushy controls. Three years after planting as cuttings, the treated plants were 159 vs. 116, and 118 vs. 82 cm. respectively.

435.3

Decoux, L. 1963. [A FIRE IN A POPLAR PLANTATION.] Bull. Soc. For. Belg. 70(8/9): 440-1. [F.]
A note on a fire caused by neglect of drainage ditches and consequent provision of fuel in the form of dense growth of Phragmites communis. Some 30 trees (Populus × robusta) were killed and 30 more suffered fire wounds.

443.3

Braun, H., and Hubbes, M. 1957. ANTIBIOTICS. SPORENINFEKTION UND ANTAGONISMUS BEI DOTHICHIZA POPULEA. [SPORE INFECTION AND ANTAGONISM IN D. POPULEA.] Naturwissenschaften 44 (11): 333. [G.]

Peno, M. 1959. NOVOZAPAZENA PATOLOSKA POJAVA NA TOPOLAMA. [A NEWLY OBSERVED PATHOLOGICAL PHENOMENON ON POPLARS.] Topola, Beograd 3(10): 872-3. [Serb.]
Describes the symptoms of an unidentified bark necrosis attacking 1- and 2-year-old sets of Populus × robusta and P. × serotina in at least two areas in Yugoslavia. Laboratory studies on the physiology of the pathogen are outlined.

———— 1960. POJAVA NOVE GLJIVICE NA TOPOLI. [THE OCCURRENCE OF A NEW FUNGUS ON POPLAR.] Topola, Beograd 4(13/14): 13-4. 1 ref. [Serb.]
The cause of a new bark necrosis of poplar [see preceding abstract] has been identified as Chaetomella tortilis (Sphaeropsidales), which normally lives in the soil as a saprophyte. Its pathogenicity is considered to be the result of abnormal soil conditions (soil exhaustion, inadequate water regime, etc.). Further details of its physiology and life history are given.

Rader-Roitzsch, J. E. 1956. BEOBACHTUNGEN UBER DAS AUFTRETEN DER CYTOSPORAKRANKHEIT AN JUNGPAPPELN. [THE OCCURRENCE OF CYTOSPORA CHRYSOSPERMA ON YOUNG POPLARS.] Schweiz. Z. Forstw. 107(8/9): 490-503. 6 refs. [G.g.f.]
Discusses possible causes of mass infections of 2-year planting stock (not cut back) of × Populus serotina, developing at many different sites in Bavaria. No obvious mistakes in tending or transport could be found, and 1-year plants at the supplying nursery showed no symptoms. From examination of roots and root collars, and preliminary experiments on the germination of Cytospora spores in soil, root infection from infected soil is considered the most likely cause.

444 CLIMBER CUTTING, ETC.

Brcak, J., and Blattny, C., Sr. 1962. ELECTRON MICROSCOPIC INVESTIGATIONS OF POPLAR MOSAIC. Phytopathology 52(9): 954-5.
Threadlike particles, with a normal (weighted average) size of 626 × 12m_μ, found on leaves of Populus × serotina exhibiting typical mosaic symptoms, are thought to represent the virus.

Frezzi, M. J. 1957. PHYTOPHTHORA CRYPTOGEA, CAUSANTE DE LA MUERTE DE POPULUS SIMONII, EN MENDOZA (ARGENTINA). [P. CRYPTOGEA CAUSING DEATH OF POPULUS SIMONII IN MENDOZA, ARGENTINA.] Rev. Argent. Agron. 24(4): 136-43. 20 refs. [Span.]
Reviews the literature on P. cryptogea, and describes its morphology, culture, and biological characteristics. A new species in Argentina, it has caused the death of many large specimens of Populus simonii, killing the roots and causing active localized cankers on the root collar and stem.

453 INSECTS

Klug, W. 1954. DIE BALSAMPAPPELN ALS FANGBAUME. [BALSAM POPLARS AS TRAP TREES.] Allg. Forstztg. 65(11/12): 155-6. [G.]
The author's suggestion is based on an observation made on indi-

vidual trees of Populus simonii, interspersed in stands of P. robusta and P. angulata. The former were heavily infested with Saperda carcharias and Cossus cossus, and were riddled with woodpecker holes from base to man's height, while the latter were hardly affected.

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Joachim, H. -F., and Templin, E. 1962. [DEATH OF POPLAR IN THE FLOODLAND FOREST OF THE ELSTER VALLEY.] NachrBl. Dtsch. PflschDienst. (Berlin) 16(5): 81-8. 23 refs. [G.g.russ.e.]

5 FOREST MENSURATION

524.315

Pozdnjakov, L. K. 1955. OB'EM I SBEG STVOLOV TOPOLJA DUZISTOGO I COZENII KRUPNOCESUJCSTOJ. [VOLUME AND TAPER OF POPULUS SUAVEOLENS AND CHOSENIA MACROLEPIS STEMS.] Soebzc. Inst. Les. No. 4: 87-91. [Russ.]
Presents volume and taper tables (both o.b. and u.b.) for 4-cm. diam. classes up to 60 cm. for P. suaveolens, and 52 cm. for C. macrolepis, both on quality I sites in Yakutia.

548 RELATION OF FOREST SITE QUALITY TO TOTAL PRODUCTION OF VEGETABLE MATTER

Decie, T. P. 1948. THE EFFECTS OF MINOR SITE VARIATIONS ON THE GROWTH OF POPLARS. Rep. on Spec. Subj., Imp. For. Inst., Oxf. 11 pp.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Dzekov, S. 1959. PRVI REZULTATI KOMPARATIVNOG GAJENJA KLONOVA P. ROBUSTA, P. REGENERATA I P. THEVESTINA NA PODRUCJU SKOPAKE KOTLINE. [PRELIMINARY RESULTS OF THE COMPARATIVE CULTIVATION OF CLONES OF POPULUS × ROBUSTA, P. × REGENERATA AND P. NIGRA VAR. THEVESTINA IN THE SKOPJE BASIN.] Topola, Beograd 3(11): 895-907. 4 refs. [Serb.g.g.]

Mutibaric, J. 1958. NEKI PODACI O PRIRASTU MLADE SASTOJINE POPULUS ROBUSTA, P. MARILANDICA I P. SEROTINA. [SOME DATA ON THE INCREMENT OF YOUNG STANDS OF P. × ROBUSTA, P. × MARILANDICA AND P. × SEROTINA.] Topola, Beograd No. 5: 384-95. 3 refs. [Serb.]

Waters, W. T. 1950. BLACK ITALIAN POPLARS AT THETFORD. J. For. Comm. No. 21: 95-7.
Data on increment.

561.25

Szodfridt, I. 1961. ADATOK A KESEINYAR ALLOMANYOK KORLAPTERULETENEK NOVEKEDESEHEZ. [BASAL AREA INCREMENT IN POPULUS SEROTINA STANDS.] Erdo 10(11): 499-504. [Hu.russ.g.]

566 YIELD TABLES AND THEIR CONSTRUCTION

Matsui, Z., and Onodera, S. 1955. [THE COMPOSITION AND GROWTH OF THE SECONDARY STAND ON THE BURNT-OVER LAND IN KITAYUBETSU DISTRICT.] Spec. Rep. For. Exp. Sta., Hokkaido No. 4: 193-216. 6 refs. [Jap.jap.e.e.]

Trifunovic, D. 1960. RACIONALNI METOD IZRADE TABLICA PRINOSA I PRIRASTA ZA JEDNODOBNE SASTOJINE KRATKE OPHODNJE. [A RATIONAL METHOD OF MAKING YIELD AND INCREMENT TABLES FOR EVEN-AGED STANDS OF SHORT ROTATION.] Sumarstvo 13(1/2): 15-28. 15 refs. [Serb.f.]
The method, based on stand age, mean diameter, mean height, and number of stems/ha., is described in detail and illustrated for Populus × serotina aged 5-35.

Volkmann, J. H. 1958. WELCHE HOLZERTRAGE SIND AUS DER STEIGERUNG DES PAPPELANBAUS IN WESTDEUTSCHLAND ZU ERWARTEN. [HOW MUCH WOOD MAY BE EXPECTED FROM THE INCREASED POPLAR GROWING IN W. GERMANY?] Allg. Forstzeitschr. 13(38): 533-6. 12 refs. [G.]

8 FOREST PRODUCTS AND THEIR UTILIZATION

810 GENERAL INFORMATION ON WOODS

Dubois, F. 1955. ESSAIS INDUSTRIELS SUR LE BOIS DU PEUPLIER DE SELYS. [INDUSTRIAL TESTS ON THE WOOD OF POPULUS SEROTINA CV. DE SELYS.] Spec. Pap. 8th Sess. Int. Poplar Comm., Madrid 1954 No. FAO/CIP/75-D Add. 1: 85-91. [F.]

Pallay, N. 1938. INFORMATORY RESEARCH ON THE TECHNICAL QUALITIES OF POPULUS CANADENSIS AND P. ROBUSTA. Erdesz. Lapok. 77(10): 850-61. [Hu.g.f.e.]

811 STRUCTURE. IDENTIFICATION

Pinker, K., and Linskens, H. F. 1958. VERGLEICHENDE UNTERSUCHUNG DER ANATOMISCHEN UND PHYSIKALISCHEN EIGENSCHAFTEN DES HOLZES VON POPULUS SIMONII UND POPULUS ROBUSTA. [COMPARATIVE STUDIES ON THE ANATOMICAL AND PHYSICAL PROPERTIES OF P. SIMONII AND P. ROBUSTA.] Holz. Roh- u. Werkstoff 16(9): 325-7. 8 refs. [G.g.e.]

811.14

Meyer-Uhlenried, K. -H. 1958. HOLZANATOMISCHE UNTERSUCHUNGEN AN DER PAPPEL. [ANATOMICAL STUDIES OF POPLAR WOOD.] Holzforschung, Berlin 11(5/6): 150-7. 30 refs. [G.g.e.]

811.156

Liese, W., and Ammer, U. 1958. UNTERSUCHUNGEN UBER DIE LANGE DER HOLZFASER BEI DER PAPPEL. [INVESTIGATIONS ON THE LENGTH OF WOOD FIBRES IN POPLARS.] Holzforschung, Berlin 11 (5/6): 169-74. 26 refs. [G.g.e.]

——— and Ammer, U. 1958. INVESTIGATIONS OF WOOD FIBRE LENGTH IN POPLAR. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 4205, 12 pp. 1958.
Transl. by W. Knie and E. Bolza from Holzforschung, Berlin 11 (5/6): 169-74.

812 PHYSICAL AND MECHANICAL PROPERTIES

Campredon, J., and Villiere, A. 1954. ETUDES SUR LE BOIS DE PEUPLIER ROBUSTA. [STUDIES ON THE WOOD OF × POPULUS ROBUSTA.] Rev. For. Franc. 6(5): 311-5. [F.]
A preliminary report on studies made by the Centre Technique du Bois at the suggestion of the International Poplar Commission, in order to determine standard methods of testing poplar wood. The study was made on 14 logs of the hybrid P. robusta from 7 trees of different provenances and included sawing, seasoning, and veneer peeling as well as mechanical strength tests.

Mutibaric, J. 1962. [SOME PHYSICAL PROPERTIES OF THE WOOD OF POPULUS × SEROTINA.] Drvna Ind. 13(7/8): 122-7. 5 refs. [Serb.e.e.]

812.8

[France: For. France] 1954. COMPTE RENDU DES RECHERCHES SUR PEUPLIERS "ROBUSTA." [RESEARCH ON THE WORKING QUALITIES OF POPULUS ROBUSTA WOOD.] For. France No. 52: 11. [F.]
Tests carried out at the Centre Technique du Bois on wood 22-32 years old indicates that veneer can be cut from logs of 35-40 cm., but not satisfactorily from smaller ones. The arrangement of branches makes it possible to cut short logs clear of all knots. The wood nails well and is suited for box manufacture. Owing to its short life, however, it is difficult to obtain large sound logs, and pulpwood is probably its best use.

813.17

Jayme, G., and Hahn, G. 1960. UBER DEN POLYURONID-GEHALT EINIGER DEUTSCHER HOLZER UND DARAUS HERGESTELLTER HOLO- UND HEMI-CELLULOSEN. [THE POLYURONIDE CONTENT OF SOME GERMAN WOODS, AND HOLO- AND HEMI-CELLULOSES MADE FROM THEM.] Holzforschung, Berlin 14(2): 52-6. 52 refs. [G.g.e.]

———— and Hahn, G. 1960. THE POLYURONIDE CONTENT OF SOME GERMAN WOODS, AND OF HOLOCELLULOSES AND HEMICELLULOSES PREPARED FROM THEM. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 5142, 12 pp. 1960. 52 refs.
Transl. by E. Pichler from Holzforschung, Berlin 14(2): 52-6.

815.3

Inokuma, T., Shimaji, K., and Furuya, M. 1962. [STUDIES ON POPLARS (2). MEASUREMENT OF FIBRE-LENGTH AND SPECIFIC GRAVITY OF YAMANARASHI (POPULUS SIEBOLDII).] Bull. Tokyo Univ. For. No. 56: 315-32. 31 refs. [Jap.jap.e.e.]

Discusses the distribution of both these characters in a 28-year stem, illustrating each with a stem-analysis diagram. Fibre length ranged from 800 to 1,260$_\mu$, mean 967.1, and sp. gr. from 0.28 to 0.64, mean 0.422. [Cf. Inokuma, Shimaji, and Hamaya, 1956, P. grandidentata to P. japono-gigas, 815.3]

832.3

Anonymous. 1945. ASPEN SOM TANDSTICKSVIRKE. [ASPEN AS A MATCH TIMBER.] Svenska SkogsvForen. Tidskr. 43(6): 479-87. [Sw.]

841.41

Meyer, K. 1954. ZUM HOLZSCHUTZ UND SEINER DURCHFUHRUNG BEIM TECHNISCH VERWENDETEN PAPPELHOLZ. [WOOD PRESERVATION METHODS FOR POPLAR WOOD IN INDUSTRIAL USE.] Abstr. in Forsch. u. Berat. (Forstw.) Landesaussch. Landw. Forsch. Landes Nordrhein-Westfalen No. 1: 136-7. [G.]

P. TREMULA

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

114.351

Bloomfield, C. 1955. EFFECTS OF LEAF EXTRACTS ON SOIL CONSTITUENTS. Rep. Rothamst. Exp. Sta. 1954: 59.

114.61/66

Runov, E. V., and Egorova, S. V. 1962 [COMPARATIVE CHARACTERIZATION OF THE SOIL MICROFLORA UNDER BROADLEAVED SPECIES IN THE TELLERMAN EXPERIMENTAL FOREST.] Soobsc. Lab. Lesoved., Moskva No. 7: 64-9. 7 refs. [Russ.]

156.2

Seiskari, P., and Suomus, H. 1958. FELLING ASPEN AND THE MANAGEMENT OF ASPEN STANDS FOR WINTER FOOD FOR GAME. Suomen Riista, Helsinki 12: 21-42. [Fi.e.]
From abstr. in Biol. Abstr. 35(8): 20335. 1960. Experiments showed that hare and elk collect to feed where aspen are felled, and that elk can be kept away from pine seedling stands by making aspen available. For continuous winter feeding, felling must be planned so that an average of only 1/40 of the aspen of an area is taken.

160.2

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160.28

Krupenikov, I. A. 1945. SALT RESISTANCE OF ASPEN UNDER NATURAL CONDITIONS. C.R. (Dokl.) Acad. Sci. U.R.S.S. 49(5): 377-80. Bblg. [E.]

161.35

Kolesnicenko, M. V. 1962. [SEASONAL VARIATION OF THE BIOCHEMICAL ACTIVITY OF EXCRETIONS FROM ASPEN LEAVES.] Fiziol. Rast. 9(6): 733-5. 8 refs.

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Jablokov, A. S. 1960. O STADIJNOJ RAZVITII LESNYH DREVESNYH POROD. [THE STADIAL DEVELOPMENT OF WOODY FOREST SPECIES.] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 40: 33-61. [Russ.russ.]

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Eklundh-Ehrenberg, C., Euler, H. von, and Hevesy, G. 1946. NOTE ON THE NUMBER OF POLLEN GRAINS IDENTIFIED IN THE FRUIT OF THE ASPEN. Arkiv. For. Kemi, Mineralogi Och Geologi, Stockh. 23B(5). 5 pp. [E.e.]

Larsen, C. M. 1954. DU RAPPORT ENTRE LE SEXE ET LE DEVELOPPEMENT CHEZ LES ARBRES DIOIQUES. [RELATIONSHIP BETWEEN SEX AND GROWTH IN DIOECIOUS TREES.] [Pap.] 8th Int. Bot. Congr. Paris, Sect. 13: 25-6. [F.]

164.6

Obminski, Z. 1953. ZOBSERWACJI I STUDIOW NAD KWITNIENIEM OSIKI. [OBSERVATIONS OF AND STUDIES ON THE FLOWERING OF ASPEN.] Sylwan 97(5): 353-61. 10 refs. [Pol.]
Summarizes provisional results of observations on the morphology and anatomy of flowers of Populus tremula.

165 PHYLOGENY, EVOLUTION, HEREDITY, GENETICS AND BREEDING, VARIATION

Johnsson, H. 1956. HETEROSISERSCHEINUNGEN BEI HYBRIDEN ZWISCHEN BREITENGRADRASSEN VON POPULUS TERMULA. [HETEROSIS IN P. TREMULA HYBRIDS FROM PARENTS OF DIFFERENT LATITUDINAL PROVENANCES.] Z. Forstgenet. 5(5/6): 156-60. 5 refs. [G.g.e.f.]

165.3

Johnsson, H. 1947. TIO ARS ASPFORADLING VID FORENINGEN FOR VAXTFORADLING AV SKOGSTRAD. [TEN YEARS' ASPEN BREEDING BY THE SWEDISH FOREST TREE BREEDING ASSOCIATION.] Medd. Foren. Vaxtforadl. Skogstrad No. 46, 9 pp. [Sw.]

165.4

Borset, O. 1944. VEKSTFOREDLING AV OSP. [SELECTIVE BREEDING OF ASPENS.] Tidsskr. Skogbr. 52(5/6): 81-97. Bblg. [Nor.]

Johnsson, H. 1939. 1938 ARS FORADLINGSARBETE MED HOGKROMOSOMIG ASP. [BREEDING WORK IN 1938 WITH POLYPLOID ASPEN.] Medd. Foren. Vaxtforadl. Skogstrad (no number). 5 pp. [Sw.e.]

———— 1940. CYTOLOGICAL STUDIES OF DIPLOID AND TRIPLOID POPULUS TREMULA AND OF CROSSES BETWEEN THEM. Hereditas, Lund 26: 321-352. Plant Breed. Abstr. 11: 212.

———— 1941. EXPERIENCES AND RESULTS FROM THREE YEARS ASPEN BREEDING BY THE SWEDISH TREE BREEDING ASSOCIATION. Svensk PappTidn. 44: 463-8, 486-8. Abstr. in Auszuge aus der Literatur—suppl. to Papierfabrikant 40(9/10): 10. 1942. [G.]

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165.41

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Dimpflmeier, R. 1963. [RESULTS OF 5 YEARS OF COMBINATIVE BREEDING EXPERIMENTS WITH POPULUS TREMULA.] Forstwiss. Cbl. 82(9/10): 295-304. 10 refs. [G.g.]

Elorrieta, J. 1957. INFORMES SOBRE LAS ACTIVIDADES DE LAS COMISIONES NACIONALES. ESPANA. INVESTIGACIONES SOBRE LOS CHOPOS CULTIVADOS EN ESPANA. [PROGRESS REPORTS OF NATIONAL POPLAR] COMMISSIONS. SPAIN. RESEARCH ON POPLARS CULTIVATED IN SPAIN.] [Docum.] 9th Sess. Int. Poplar Comm., Paris 1957 No. FAO/CIP/86-F Add. 2, 2 pp. [Span.]
Includes a report on heterosis observed in Populus tremula × P. alba and P. tremula × P. alba var. bolleana hybrids, in contrast to the experience of W. Wettstein and C. Heimburger, who obtained poor results with the first combination.

Janson, L. 1960. ANALIZA PRZYROSTU SIEWEK MIESZANCOW TOPOLI. [ANALYSIS OF GROWTH OF HYBRID POPLAR SEEDLINGS.] Sylwan 104(1): 77-89. [Pol.russ.e.] (Biul. Inst. Bad. Lesn. No. 1. 1960.)

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———— 1945. THE TRIPLOID PROGENY OF THE CROSS DIPLOID × TETRAPLOID POPULUS TREMULA. Hereditas, Lund 31(3/4): 411-40.

———— 1945. CHROMOSOME NUMBERS OF THE PROGENY FROM THE CROSS TRIPLOID × TETRAPLOID POPULUS TREMULA. Hereditas, Lund 31(3/4): 500-1.

Konovalov, N. A. 1960. URAL'SKAJA PIRAMIDAL'NAJA OSINA. [THE URALS FASTIGIATE ASPEN.] Lesn. Z., Arhangel'sk 3(3): 156-7. 4 refs. [Russ.]
A brief description of the hybrid, produced by crossing Populus tremula O with P. jablokowii (i.e. P. tremula × P. bolleana), with notes on its propagation. It is a decorative, frost-resistant tree, of interest for park and street planting.

Nilsson-Ehle, H. 1938. FRAMSTALLNING AV SKOGSTRAD MED OKAT KROMOSOMTAL OCH OKAD VIRKESPRODUKTION. [PRODUCTION OF FOREST TREES WITH INCREASED CHROMOSOME NUMBER AND INCREASED TIMBER YIELD.] Svensk PappTidn. No. 2, 5 pp. [Sw.] Plant Breed. Abstr. 10: 883.

Schonbach, H. 1960. EINIGE ERGEBNISSE ACHTJAHRIGER ZUCHTUNGSVERSUCHE MIT PAPPELARTEN DER SEKTION LEUCE. [SOME RESULTS OF 8-YEAR-OLD BREEDING TRIALS WITH POPLAR VARIETIES OF THE SECTION LEUCE.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 44 (Beitr. Pappelforsch. No. 4): 7-21. 3 refs. [G.g. russ.e.] [Cf. Schonbach, 1957, Populus Section Leuce, 165.41.]

———— 1962. ERGIBT DIE KREUZUNG POPULUS TREMULA × POPULUS ALBA (UND REZIPROK) LUXURIENDE BASTARDE? (EIN BEITRAG ZUM HERREROSISPROBLEM BEI WALDBAUMEN.) [DO CROSSES OF P. TREMULA × P. ALBA AND RECIPROCAL CROSSES PRODUCE HYBRID VIGOR? (A CONTRIBUTION TO THE PROBLEM OF HETEROSIS IN FOREST TREES.)] Silvae Genet. 11(1): 3-11. 26 refs. [G.g.e.f.]

———— and Dathe, B. 1962. [RESULTS OF 12 YEARS' BREEDING WORK WITH INDIGENOUS ASPEN AND PROPOSALS FOR PRACTICAL APPLICATION.] Sozial. Forstw., Berlin 12(10): 309-15. 9 refs. [G.g.]

Seitz, F. W. 1954. UBER DEN SELBSTUNGS - UND KREUZUNGSERFOLG BEI VERWENDUNG DES POLLENS DER ZWITTRIGEN GRAUPAPPEL VON DILLINGEN. [RESULTS OF SELFING AND CROSSING USING POLLEN OF THE DILLINGEN ANDROGYNOUS GREY POPLAR.] Abstr. in Z. Forstgenet. 3(6): 141. [G.]

———— 1958. FRUHTREIBVERSUCHE MIT BLUHREISERN DER ASPE. [EXPERIMENTS IN EARLY DEVELOPMENT OF FLOWERING BRANCHES OF ASPEN.] Silvae Genet. 7(3): 102-5. 8 refs. [G.g.e.f.]

———— 1959. EINIGE ERFAHRUNGEN BEI DER ANZUCHT VON ASPENSAMLINGEN. [SOME EXPERIENCES IN RAISING ASPEN FROM SEED.] From abstr. in Silvae Genet. 8(4): 124-5. [G.]
Advocates a method of cutting back first-year seedlings, in order to spread over 2 years experiments in diallele crossings of aspen, thereby obtaining a larger quantity of material for investigation.

Wettstein, W. von. 1937. INCREASING PERFORMANCE BY CROSSING TREES OF DIFFERENT PROVENANCE IN POPULUS TREMULA. Naturwissenschaften 25: 434-436. Plant Breed. Abstr. 8(5): 493. 1938.

Wettstein, W. 1954. KURZE INFORMATION UBER DIE ZITTERPAPPEL ("ASPE"). [A NOTE ON POPULUS TREMULA.] Allg. Forstztg. 65 (21/22): 263-4. [G.]
A general description of distribution, site requirements, growth characteristics and uses, with an account of earlier (1936-39) experiments in crossing plants from widely distant habitats, followed by a table, with explanations, giving 1st-year growth results for 26 inter- and intraspecific crossings of P. tremula, P. alba, P. grandidentata, and P. tremuloides. All hybrids showed better growth than P. alba, and local combinations were better than combinations with American species. Hot-house ripened seeds lengthened the vegetation period and resulted in bigger 1-year seedlings.

Zurbin, A. I. 1951. POVYSENIE SKRESCIVAEMOSTI VIDOV TOPOLEI PRI POMOSCI PREDVARITELJNOGO VOGETATIVNOGO SBLIZENIJA. [INCREASING THE CAPACITY OF POPLAR SPECIES FOR HYBRIDIZATION BY PREVIOUS GRAFTING [OF ONE PARENT UPON A STOCK OF THE OTHER].] Priroda, Moskva 40(4): 66. [Russ.]

165.42

Muntzing, A. 1936. THE CHROMOSOMES OF A GIANT POPULUS TREMULA. Hereditas, Lund 21: 383-93. Plant Breed. Abstr. 6(4): 1405. 1936.

Sarvas, R. 1958(1959). KAKSI TRIPLOIDISTA HAAPAA JA KOIVUA. [TWO TRIPLOID ASPENS AND TWO TRIPLOID BIRCHES.] Commun. Inst. For. Fenn. 49(7). 25 pp. 21 refs. [Fi.e.e.]
An account of the growth characteristics and chromosome complement of two Populus tremula clones and two specimens of Betula verrucosa, the only triploid trees of these species so far discovered in Finland.

Tometoip, G. 1937. THE CHROMOSOME NUMBERS OF TWO NEW GIANT POPULUS TREMULA. Bot. Notiser 1937: 285-90. Plant Breed. Abstr. 8(2): 191. 1938.

Tralau, H. 1957. UBER EINE HAPLOIDE FORM VON POPULUS TREMULA AUS UPPLAND. [A HAPLOID FORM OF P. TREMULA FROM UPPLAND.] Bot. Notiser 110(4): 481-3. 16 refs. [G.]
Describes a spontaneous haploid form, characterized by its bushy and stunted growth, and small leaves. Chromosome numbers in the root tips were $2n = \pm 19$.

165.43

Johnsson, H. 1953. DEVELOPMENT OF TRIPLOID AND DIPLOID POPULUS TREMULA DURING THE JUVENILE PERIOD. Z. Forstgenet. 2(4): 73-7. 7 refs. [E.e.g.]

Mattila, R. E. 1961. ON THE PRODUCTION OF THE TETRAPLOID HYBRID ASPEN BY COLCHICINE TREATMENT. Hereditas, Lund 47 (3/4): 631-40. 7 refs. [E.e.]
Seeds of hybrid aspen (Populus tremula × P. tremuloides) were treated with 0.1% colchicine solution. The appearance and stomatal characteristics of seedlings produced are described. Growth of amphidiploid seedlings was satisfactory.

165.5

Anonymous 1937 A SPONTANEOUS GIANT FORM OF POPULUS TREMULA. Bull. Soc. For. Belg. 44(1): 22-6.

Blomquist, S. G. 1937 ON POPULUS TREMULUS GIGAS. Bot. Notiser 1937(1/2): 119-23. Plant Sci. Lit. 5(17): 7. 1937.

Bonde, C. P. 1939. SOME OBSERVATIONS ON THE PLANTATIONS NOW MADE OF GIANT ASPEN. Skogsagaren 15(6): 147-9. [Sw.]

Bouvarel, P., and Fourchy, P. 1954. A PROPOS DU TREMBLE DES ALPES. LES TREMBLES DE LA VALLEE DU FERRAND (ISERE). [THE ALPINE RACE OF ASPENS; THE ASPENS OF THE VALLEE DU FERRAND (ISERE).] Rev. For. Franc. 6(10): 601-3. 2 refs. [F.]

Gambi, G. 1954. IL PIOPPO TREMULO DELL' ASPROMONTE. [THE ASPROMONTE ASPEN.] Monti e Boschi 5(4): 161-4. [It.f.e.]
Describes a race of Populus tremula of particularly good form and vigorous growth, occurring at Aspromonte (Calabria).

Konovalov, N. A. 1963. [SELECTION AND BREEDING OF FAST-GROWING TREE SPECIES IN THE CENTRAL URALS.] Lesn. Hoz. 16(7): 55-8. [Russ.]

Melander, Y. 1938. A NEW GIANT POPULUS TREMULA IN NORRBOTTEN. Hereditas, Lund 24(1/2): 189-94. Plant Sci. Lit. 7(8): 8. 1938.

Nilsson-Ehle, H. 1936. ON A GIGAS FORM OF P. TREMULA FOUND IN NATURE. Hereditas, Lund 21: 379-82. Plant Breed. Abstr. 6(4): 1404. 1936.

———— 1938. JATTEASPEN. DEN MODERNA SVENSKA SKOGSFORADLINGENS UPPTACKT. [THE GIANT ASPEN. THE RECENT SWEDISH DISCOVERY IN FOREST IMPROVEMENT.] Nord. Familjeboks Manadskronika 1(2). 6 pp. [Sw.] Plant Breed. Abstr. 10: 884.

Ojamaa, M. M. 1961. BIOLOGICESKIE FORMY OSINY V LESAH JUZNOJ CASTI ESTONII. [BIOLOGICAL FORMS OF POPULUS TREMULA IN S. ESTONIA.] Lesn. Hoz. 14(2): 11-4. [Russ.]
Describes the four forms [see following reference]; the grey-barked form is the commonest here too, and the green-barked form is the best, particularly as regards resistance to heart rot. Thinnings should favor the green-, and remove the grey- and dark-barked forms.

Orlenko, E. 1960. WARTOSCIOWA FORMA OSIKI ROASNCEJ W LASACH BIALORUSI. [A VALUABLE FORM OF ASPEN GROWING IN BELORUSSIA.] Sylwan 104(1): 15-9. 7 refs. [Pol.]

Sarvas, R. 1950. JATTILAISHAAPA HELSINGIN KAUPUNGISSA. [A GIANT ASPEN IN HELSINKI.] Metsat. Aikak. 1950(3/4): 98-100. 7 refs. [Fi.e.]

Wettstein, W. von. 1937. INDIVIDUAL DIFFERENCES BETWEEN ASPEN SEEDLINGS. Forstarchiv 13(9): 149-51. [G.]

Yablkov, A. S. 1941. ISPOLINAKAY FORMA OSINY V LESAKH U.S.S.R. [A FORM OF POPULUS TREMULA GIGANTEA IN THE FORESTS OF THE U.S.S.R.] Trud. Vsesoyuz. Nauchno-issledov. Inst. Lesnogo Khoz. 'VNIILKh' No. 23, 52 pp. Bblg. [Russ.russ.]

Zachej, S. 1961. VYBEROVE STROMY OSIKY. [SELECTED SPECIMENS OF ASPEN.] Lesn. Cas. 7(5): 319-30. 9 refs. [Slovak.slovak. russ.g.]
Lists the locality, age, dimensions, and form of 62 selected good specimens of Populus tremula found by the author in Slovakia, and useful for breeding and propagation. [See Zachej, 1960, P. tremula, 181.1.]

165.53

Danilov, M. D. 1954. RANO- I POZDNORASPUSKAJUSCIESJA FORMY OSINY. [THE EARLY- AND LATE-FLUSHING FORMS OF POPULUS TREMULA.] Bjulleten' Moskovskogo Obscestva Ispytatelej Prirody (Otdel Biol.), Moskva 59(5): 21-39. [Russ.] From abstr. in Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 11: 540. 1956. [Pol.]

Liebeswar, K. 1961. BEOBACHTUNGEN UBER DEN ZEITPUNKT DES AUSTRIEBES VERSCHIEDENER LAUBBAUME UND DEREN VEGETATIVER UND GENERATIVER NACHKOMMENSCHAFTEN. [FLUSHING DATES OF SOME BROADLEAVED TREES AND THEIR VEGETATIVE AND SEEDLING PROGENY.] Allg. Forstztg. 72(21/22), Suppl. (Informationdienst No. 50), p. 2. 8 refs. [G.]

Sylven, N. 1940. LANG- OCH KORTDAGSTYPER AV DE SVENSKA SKOGSTRADEN. [LONG- AND SHORT-DAY TYPES OF SWEDISH FOREST TREES.] Svensk PappTidn. 43: 317-24, 332-42. [Sw.]

165.7

Gombocz. 1928. ARTIFICIAL CROSSING BETWEEN P. ALBA AND P. TREMULA. Biol. Abstr. 2: 15669.

165.71

Catalan, G. 1963. [CROSSES WITHIN THE SECTION LEUCE AND A NOTABLE HYBRID BETWEEN LEUCE AND AIGEIROS.] [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63-2b/8, 3 pp. [Span.span.]

168 HISTOLOGY

Barnoud, F. 1956. SUR LA CULTURE DU TISSU CAMBIAL DES CARPINUS BETULUS L., POPULUS TREMULA L., ET QUERCUS SESSILIFLORA SM. [THE CULTURE OF CAMBIAL TISSUE OF C. BETULUS, P. TREMULA AND Q. SESSILIFLORA.] C.R. Acad. Sci., Paris 242(11): 1508-9. 2 refs. [F.f.]
Cultures of all three have been maintained successfully for about 2 years. The addition of coconut milk stimulated the growth of C. betulus cultures but had little effect on cultures of aspen and none on those of oak.

Jacquiot, C. 1956. SUR LES BESOINS EN AUXINE ET LES CARACTERES MORPHOLOGIQUES EXTERNES DES CULTURES DE TISSU CAMBIAL DE QUELQUES ESPECES D'ARBRES. [THE GROWTH-REGULATOR REQUIREMENTS AND EXTERNAL MORPHOLOGICAL CHARACTERISTICS OF CULTURES OF CAMBIAL TISSUE OF SOME TREES.] C.R. Acad. Sci., Paris 243(5): 510-2. 2 refs. [F.]
Includes details of the requirements of Castanea sativa, Ulmus campestris, Betula verrucosa, Tilia parvifolia, and Populus tremula.

———— 1958. RECHERCHES SUR LA RHIZOGENESE CHEZ LE TISSU CAMBIAL DE POPULUS TREMULA L. CULTIVE IN VITRO. [RHIZOGENESIS IN CAMBIAL TISSUE OF P. TREMULA GROWN IN VITRO.] C.R. Acad. Sci., Paris 247(18): 1489-92. 3 refs. [F.f.]
In vitro cultures from three aspens from different parts of France showed that the ease of rooting cuttings of a clone is in direct relation to the ease of root formation by cambial tissue. Tissue that does not readily form roots can be stimulated by the proximity of one that does.

Saatcioglu, F. 1956. BOZKAVAK (POPULUS CANESCENS SMITH) MELEZINIM SUN'I CAPRAZLAMA METODIYLE ELDE EDILMESI. [ARTIFICIAL PRODUCTION OF POPULUS CANESCENS BY CROSSING.] Istanbul Univ. Orm. Fak. Derg. 6(2): 70-91. 13 refs. [Turk.g.g.]
Gives details of the laboratory hybridization and culture of P. alba × P. tremula and P. tremula × P. alba, the early nursery growth of which was 20% greater than selfed P. alba. Leaves of the two crosses and of pure P. alba are illustrated.

Scepotjev, F. L. 1954. NOVYE GIBRIDNYE FORMY OSINY. [NEW HYBRID FORMS OF ASPEN.] Dokl. Akad. Nauk SSSR 97(1): 161-4. 2 refs. [Russ.]

176.1

Guse. 1891. DESCRIPTION OF P. TREMULA. Zeitschr. F. & J. 23: 60-71.

Jancarik, V. 1957. OCHRANA SEMENACKU OSIKY VE SKOLKACH. [PROTECTING ASPEN SEEDLINGS IN NURSERIES.] Prace Vyzkum. Ust. Lesn. CSR No. 13: 125-148. 10 refs. [Cz.russ.e.]

Jovanovic, B., and Tucovic, A. 1960. TAKSONOMSKA PROUCAVANJA JASIKE (POPULUS TREMULA L.) ODNOSNO T.ZV. BAHOFENOVE TOPOLE NA DELIBLATSKOJ PESCARI. [TAXONOMIC STUDIES ON ASPEN (P. TREMULA) WITH REFERENCE TO THE SO-CALLED BACHOFEN POPLAR ON THE DELIBLATO SANDS.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 1: 5-41. 24 refs. [Serb.serb.g.]

Nilsson. 1932. NOTE ON P. TREMULA. Bot. Cur. Lit. 14(15): 1

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Borset, O., and Haugberg, M. 1960. OSPA. [POPULUS TREMULA.] Det Norske Skogselskap, Oslo. 176 pp. 6 pp. of refs. [Nor.]

A comprehensive handbook covering: its position in Norwegian forestry; botanical description; ecology; diseases and injuries; natural and artificial regeneration; tending; increment; properties and uses of the wood; felling and transport; marketing and grading; economic aspects; and breeding.

Burger, D. 1920. BEITRAGE ZUR LEBENSGESCHICHTE DER POPULUS TREMULA L. Eidengen, Tech. Hochsch. Zurich. Promotionsarbeit.

Marcet, E. 1954. ASPE UND WEISSPAPPELN, WALDBAULICH UND WIRTSCHAFTLICH WICHTIGE BAUMARTEN DER ZUKUNFT. [ASPEN AND WHITE POPLARS, SPECIES OF SILVICULTURAL AND INDUSTRIAL IMPORTANCE FOR THE FUTURE.] Schweiz. Z. Forstw. 105(8): 425-50. 53 refs. [G.f.]
Reviews European work on breeding, propagation, and increment of Populus tremula, comparing it with other poplars of the section Leuce, and gives some data on increment and yield from plots at Zurich.

Martenot. 1889. P. TREMULA IN RUSSIA. Rev. E. & F. 28: 262.

Petrini. 1928. ASPEN IN SWEDEN. Biol. Abstr. 2: 18520.

181.1

Anonymous. 1903. NOTE OF P. TREMULA IN EUROPE. Bull. Soc. For. Belg. 10: 104.

Dansereau, P. 1940. EXTENSION AU VALAIS DE L'AIRE DU POPULUS TREMULA VAR. FREYNI HERVIER. [EXTENSION OF THE RANGE OF POPULUS TREMULA VAR. FREYNI TO VALAIS.] Bull. Soc. Bot. Geneve, Ser. 2(30): 221-9. Bblg. [F.]

Pospisil, J. 1958. ROZSIRENI OSIKY V CSR. [THE DISTRIBUTION OF POPULUS TREMULA IN CZECHOSLOVAKIA.] Sborn. Csl. Akad. Zemed. (Lesn.) 4(9): 761-80. 20 refs. [Cz.russ.g.]

S., E. E. 1948. BLAEOSP FUNDIN A AUSTURLANDI. [POPULUS TREMULA IN EASTERN ICELAND.] Arsr. Skograektarf. Islands 1948: 123-4. [Ice.]
A number of young trees, the tallest ½ m. high, have been found in heavily-grazed birch scrub. This is the 2nd record of P. tremula growing naturally in Iceland.

Zachej, S. 1960. PRIRODZENE ROZSIRENIE OSIKY (POPULUS TREMULA L.) NA SLOVENSKU. [NATURAL DISTRIBUTION OF P. TREMULA IN SLOVAKIA.] Ved. Prace Vyskum. Ust. Lesn. Hosp. Bansk. Stiav. No. 1: 179-95. 11 refs. [Slovak.slovak.russ.g.]

181.21

Zehngraff, P. J. 1947. RESPONSE OF YOUNG ASPEN SUCKERS TO OVERHEAD SHADE. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 278, 1 p.

181.3

Langhammer, A. 1962. OSPAS KRAV TIL JORDBUNNEN. [SOIL REQUIREMENTS OF ASPEN.] Norsk Skogbr. 8(11/12): 369-70. [Nor.]
Discusses briefly the type of Norwegian soil and site where natural regeneration of aspen might be more profitable than spruce plantations.

181.312

Smirnov, V. V., and Odinokova, N. S. 1954. GIDROLOGICESKAJA ROLJ OSINOVYH LESOV. [THE HYDROLOGICAL ROLE OF ASPEN WOODS.] Dokl. Akad. Nauk. SSSR 99(5): 849-52. 10 refs. [Russ.]

181.33

Domanski, W. 1954. SIEDLISKO I WZROST OSIKI. [THE SITE AND GROWTH OF ASPEN.] Las Polski, Warsz. 28(5): 16-7. [Pol.]
From abstr. in Prehl. Lesn. Lit. 5(10): 3852. 1954 [Cz.]

181.34

Remezov, N. P., and Bykova, L. N. 1953. POTREBLENIE I KRUGLOVOROT AZOTA I ZOLJNYH ELEMENTOV V OSINNIKAH [UPTAKE AND CYCLE OF N AND ASH ELEMENTS IN ASPEN STANDS.] Pocvoved. 1953 1(8): 28-41. 2 refs. [Russ.]

181.343

Bloomfield, C. 1954. A STUDY OF PODZOLIZATION. V. THE MOBILIZATION OF IRON AND ALUMINUM BY ASPEN AND ASH LEAVES. J. Soil Sci. 5(1): 50-6. 10 refs.

181.35/36

Siren, G., and Bergman, F. 1951. SVAMPARNA OCH VARA SKOGSTRAD. [[MYCORRHIZAL] FUNGI AND OUR FOREST TREES.] Skogsbruket, Helsingfors 21(2): 39-43. 5 refs. [Sw.]

181.51

Eliasson, L. 1961. THE INFLUENCE OF GROWTH SUBSTANCES ON THE FORMATION OF SHOOTS FROM ASPEN ROOTS. Physiol. Plant., Copenhagen 14(1): 150-6. 13 refs. [E.e.]

181.52

Al'Benski, A. V. 1940. THE TRANSFORMATION OF ASPEN FROM A DIOECIOUS INTO A MONOECIOUS PLANT. Dokl. Vsesoyuz. Akad. S.-Kh. Nauk 1940(19): 27-29. [R.]

Sylven, N. 1942. NAGRA ORD OM ASPENS HETEROFYLLI. [SOME NOTES ON HETEROPHYLLY IN ASPEN.] Svensk Bot. Tidskr. 36(2/3): 273-82. Bblg. [Sw.]

181.521

Gorjunova, L. N. 1961. KLON ODNODOMNOJ OSINY POPULUS TREMULA L. NA KOL'SKOM POLUOSTROVE. [A MONOECIOUS CLONE OF P. TREMULA IN THE KOLA PENINSULA.] Bot. Z. 46(5): 705-7. 5 refs. [Russ.]
Describes the discovery of the clone, which consists of 53 trees 30-35 years old, in the Murmansk region. Experiments showed that protogyny occurred in the monoecious flowers of androgynous catkins.

Gramuglio, G. 1962(1963). [THE SEXUAL BEHAVIOR OF POPULUS TREMULA IN ITALY.] G. Bot. Ital. 69(1/3): 78-90. 11 refs. [It.it.e.]

Lazarevic, Z., and Korac, M. 1958. O POJAVI POLIGAMIJE KOD POPULUS TREMULA. [A CASE OF POLYGAMY IN P. TREMULA.] Sumarstvo 11(1/2): 66-8. 7 refs. [Serb.]
Cites an example of P. tremula growing in a private garden in Belgrade, on which, in addition to ♀ catkins, ♂ flowers were found.

Pettersson, B. 1950. AN EXPERIMENTAL INVESTIGATION OF THE DISPERSAL OF MAINLY ANEMOCHOROUS NORDIC PHANEROGAMS. Abstr. Pap., 7th Int. Bot. Cong., Stockh. 2 pp.
Floating capacity in air and buoyancy in water were determined for the disaspores of a number of species, including Salix caprea and Populus tremula.

Ruggeri, C. 1960(1961). QUALCHE OSSERVAZIONE SULLE GEMME DI POPULUS TREMULA L. [THE BUDS OF P. TREMULA.] Nuovo G. Bot. Ital. (n.s.) 67(3/4): 610-3. 5 refs. [It.it.e.]
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———— 1963. [OBSERVATIONS IN ANOMALOUS FLOWERS OF POPULUS TREMULA.] Bubbl. Cent. Sper. Agric. For., Roma 6: 47-56. 10 refs. [It.it.e.e.]

———— 1963. OBSERVATIONS ON THE BISEXUAL BEHAVIOR OF A POPULATION OF POPULUS TREMULA L. [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-1/8. 2 pp. 2 refs.

Runquist, E. W. 1951. ETT FALL AV ANDROGYNA HANGEN HOS POPULUS TREMULA L. [A CASE OF ANDROGYNOUS CATKINS ON P. TREMULA.] Bot. Notiser 1951(2): 188-91. 11 refs. [Sw.g.]

Sauer, E. 1954. BEOBACHTUNGEN AN ZWITTRIGEN PAPPELN. [OBSERVATIONS ON ANDROGYNOUS POPLARS.] Z. Forstgenet. 3(5): 89-91 6 refs. [G.g.e.]
A study of the androgynous flowers of a young Populus tremula at Stuttgart. Mention is also made of the occurrence of androgynous flowers on an adult P. alba (or possibly P. alba × P. canescens) and a young P. candicans. [*Cf. Seitz, 1954, P. alba to P. bachofeni, 165.41.*]

Seitz, F. W. 1952. ZWEI NEUE FUNDE VON ZWITTERIGKEIT BEI DER ASPE. [TWO NEW EXAMPLES OF HERMAPHRODITISM IN ASPEN.] Z. Forstgenet. 1(3): 70-3. 11 refs. [G.g.]

———— 1952. WEITERE BEOBACHTUNGEN AM ZWITTRIGEN ASPENKLON VON DILLINGEN (DONAU). [FURTHER OBSERVATIONS ON THE ANDROGYNOUS ASPEN CLONE FROM DILLINGEN (DONAU).] Abstr. in Z. Forstgenet. 2(1): 22. [G.]

———— 1953. UBER ANOMALE ZWITTERBLUTEN EINES KLONES DER GATTUNG POPULUS, SEKTION LEUCE. [ANOMALOUS ANDROGYNOUS FLOWERS OF A CLONE OF THE SECTION LEUCE OF THE GENUS POPULUS.] Z. Forstgenet. 2(4): 77-90. 24 refs. [G.g.e.]

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Eliasson, L. 1962. THE RESPONSE OF ASPEN ROOTS TO 3-AMINO-1,2,4-TRIAZOLE. Physiol. Plant., Copenhagen 15(2): 229-38. 29 refs. [E.e.]

———— 1962. RESPONSES OF ASPEN ROOTS TO AUXINS WITH PARTICULAR REGARD TO THE EFFECTS OF CHLORINATED PHENOXYACETIC ACIDS. Physiol. Plant., Copenhagen 15(4): 753-63. 31 refs. [E.e.]

———— 1962. UNDER SOKNINGAR BETRAFFANDE ASPENS FYSIOLOGISKA REAKTIONER FOR SYSTEMISKA HERBICIDER. [STUDIES ON PHYSIOLOGICAL REACTIONS OF ASPEN TO SYSTEMIC HERBICIDES.] K. Skogs- o. LantbrAkad. Tidskr., Stockh. 101(1/2): 202-24. 65 refs. [Sw.e.]

———— 1963. RESPONSES OF ASPEN ROOTS TO AUXIN-TYPE GROWTH SUBSTANCES APPLIED TO THE LEAVES. Physiol. Plant., Copenhagen 16(1): 201-14. 40 refs. [E.e.]

Marjai, Z. 1956. NYARMAG CSIRAZASFIZIOLOGIAI VIZSGALATOK. [GERMINATION-PHYSIOLOGICAL INVESTIGATIONS ON POPLAR SEEDS.] Erdesz. Kutatas., Budapest 1956(3): 95-109. 13 refs. [Hu.russ. e.g.]

Smirnov, V. N., Griskun, E. V., and Usynina, V. A. 1962. [THE PHYSICOCHEMICAL AND BIOCHEMICAL CHARACTERISTICS OF SOD-PODZOLIC SOILS OF THE RHIZOSPHERE OF PINE, SPRUCE, AND ASPEN.] Lesn. Z., Arhangel'sk 5(6): 3-8. 16 refs. [Russ.]
Compares in tables the properties of the rhizosphere and non-rhizosphere soil under Pinus sylvestria, Picea abies, and Populus tremula.

Volger, C. 1961. [REMARKABLE EFFECTS OF SOME SOIL STERILIZERS ON THE RAISING OF POPULUS TREMULA.] Meded. Landb-Hogesch. Gent 26(3): 1385-93. 6 refs. [G.]

181.6

Borset, O. 1957. VEKSTEN HOS HAN- OG HUNTRAER AV OSP. [GROWTH OF MALE AND FEMALE ASPEN.] Medd. Norske Skogforsoksv. 14(48): 175-85. 12 refs. [Nor.e.]
Female trees, on a plot in southern Norway grew faster in height and diameter in 1944-52 than male trees. However, it seems probable that each sex is represented by only one clone, and other experiments in seedling plantations should be made. Literature on growth of other dioecious species is discussed.

Turesson, G. 1961. HABITAT MODIFICATIONS IN SOME WIDESPREAD PLANT SPECIES. Bot. Notiser 114(4): 435-52. 30 refs. [E.e.]
Describes some modifications in growth habit taking place in dwarf forms of Populus tremula, Sorbus aucuparia, and Juniperus cummunis (among other species), when transplanted to the Botanical-Genetics Garden of the Royal Agricultural College at Uppsala.

181.69

Fedorov, M. A. 1955. INTERESNYI SLUCAI SRASTANIJA DUBA S OSINOI. [AN INTERESTING CASE OF NATURAL STEM-GRAFTING BETWEEN OAK AND ASPEN.] Priroda, Moskva 44(5): 114-5. [Russ.]
Describes apparent natural grafting at three points on the stems of an oak and an aspen of coppice and sucker origin respectively. No anatomical study has been made of the tissues at the "unions," but an attempt is to be made to prove true grafting by using tracer atoms.

181.71

Ausland, T. 1957. STORE OSPER. [LARGE ASPENS.] Norsk Skogbr. 3(22): 597, 609. [Nor.]
Three trees, the tallest examples recorded in Norway, have measured heights of 31.74, 31.16, and nearly 30 m., and d.b.h. of 42.6, 41.7, and 46.3 cm. respectively. The green crown in all three occupies about half the stem height. The trees are ca. 60 years old.

182 SYNECOLOGY. PLANT SOCIOLOGY

Tjurin. 1931. DEVELOPMENT OF ASPEN STANDS IN RUSSIA. Allg. Forst- u. Jagdztg. 107: 59.

182.21

Smirnov, V. V. 1959. PROISHOZDENIE, RAZVITIE I SMENA POKOLENIJ OSINNIKOV V NAGORNYH DUBRAVAH JUZNOJ LESOSTEPI. [ORIGIN, DEVELOPMENT, AND SUCCESSION OF ASPEN STANDS IN UPLAND OAK FORESTS OF THE SOUTHERN FOREST-STEPPE ZONE.] Soobsc. Inst. Les. No. 11: 51-70. 20 refs. [Russ.] [Cf. Smirnov, 1959, P. tremula, 231.5.]

182.3

Eklund. 1925. INVESTIGATIONS IN ASPEN FORESTS OF SWEDEN. Forstl. Jahresb., p. 215.

———— and Wenmark. 1925. SOME INVESTIGATIONS IN ASPEN Svenska SkogsvForen. Tidskr. 23: 80-104, 125-42.

———— and Wenmark. 1925. SOME INVESTIGATIONS IN ASPEN FORESTS. Bot. Abstr. 14: 1171.

Vlymen, V. P., van. 1949. ASPEN GROVE TYPE (1921 BURN), IROQUOIS FALLS, ONTARIO. Pulp Paper Mag. Can. 50(12): 130, 132, 134.

187 VEGETATION TYPES

Ipatov, V. S. 1960. TIPY OSINOVYH LESOV SEVEROZAPADA RSFSR. [POPULUS TREMULA FOREST TYPES IN THE N.W. OF THE R.S.F.S.R.] Vestnik Leningradskogo Universiteta (Serija Biologii) 15(3) No. 1:23-40. [Russ.e.]
Describes nine types in the Leningrad, Pskov, and Novgorod regions, characterized by: Calamagrostis lanceolata; Filipendula ulmaria; 'herbae magnae'; 'herbae nemorales'; Oxalis acetosella; C. arundinacea; Vaccinium myrtillus; V. vitis-idaea/Sphagnum; C. arundinacea (dry type).

Ivanov, V. V. 1952. OSINOVAJA ROSCA V PRIKASPIISKIH STEPJAH. [AN ASPEN WOOD [NEAR BEL'-AGACH] IN THE CASPIAN STEPPES [W. KAZAKHSTAN].] Priroda, Moskva 41(2): 110-1. 1 ref. [Russ.]

2 SILVICULTURE

Barth, A. 1942. ASPEN, DENS KULTUR OG BEHANDLING FOR KVALITETSPRODUKSJON. [ASPEN [POPULUS TREMULA], ITS CULTIVATION AND TREATMENT FOR THE PRODUCTION OF HIGH-GRADE TIMBER.] Publ. Ingenior F.H. Frolichs Fond for Aspeskogbrukets Fremme No. 1, 87 pp. Bblg. [Nor.]

Blumenthal, B. -E. 1942. STUDIER ANGAENDE ASPENS FOREKOMST OCH EGENSKAPER I FINLAND. [STUDIES ON THE OCCURRENCE AND PROPERTIES OF ASPEN IN FINLAND [WITH SPECIAL REFERENCE TO INCREMENT, LENGTH OF CLEAR BOLE, BARK THICKNESS, ROT DAMAGE AND ITS AVOIDANCE BY SILVICULTURAL MEASURES].] Silva Fenn No. 56, 63 pp. Bblg. [Sw.g.]

Borset, O. 1960. SILVICULTURE OF ASPEN. Scot. For. 14(2) 68-80.
Summarizes the results of Norwegian research aiming at producing high quality aspen (Populus tremula) for matchstock.

Hofmann. 1902. CULTIVATION OF ASPEN. Forstwiss. Cbl. 24: 360

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Largerberg. 1923. ASPEN CULTURE IN SWEDEN (EXTRACT) . For. 21: 627.

Pablo. 1936. THE SILVICULTURAL VALUE OF THE ASPEN. Skogen 23(12): 239-41. [Sw.]

Perdrizet, G. 1948. CONTRIBUTION A LA MONOGRAPHIE DU PEUPLIER TREMBLE-SA REPARTITION SYLVICOLE ET COMMERCIALE EN FRANCE. [CONTRIBUTION TO A MONOGRAPH ON ASPEN—ITS SILVICULTURAL AND COMMERCIAL DISTRIBUTION IN FRANCE.] Rev. Bois Appl. 3(1): 12-4. [F.]

Petrini, S. 1944-45. TRE FORSOKSYTOR I ASPSKOG. [THREE SAMPLE PLOTS IN ASPEN WOODS.] Medd. Skogsforsoksanst. Stockh. 34: 309-25. [Sw.sw.e.]

Schotte. 1917. SEVEN EXPERIMENTAL PLOTS OF ASPEN. Meq. Stat. Skogsforsoksanstalt (Sweden) 2(13-14): 1205-20. [Fr. smry. on p. 9.]

Silvy-Leligois, P. 1949. OBSERVATIONS SUR LE TREMBLE EN MAURIENNE. [NOTES ON THE ASPEN IN MAURIENNE (SAVOIE).] Rev. For. Franc. No. 8: 362-70. 16 refs. [F.]

Vill. 1934. DER ANBAU DER ASPE. [THE CULTIVATION OF ASPEN.] Dtsch. Forstbeamte 2: 235-6. Forstl. Rundschau 7: 133. 1934. [G.]

222.1

Cointat, M. 1951. LE TREMBLE DANS LA FORET DU DER. [POPULUS TREMULA IN THE FOREST OF DER (HAUT HARNE).] Rev. For. Franc. 1951(12): 759-62. [F.]
Aspen was favored as a standard over coppice in the 19th century, but its place was later taken by lime and later by birch. A comparison is made between increment of aspen on marls and on calcareous soils.

228 CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Wijkstrom, S. 1945. GYNNA ASPEN PA LAMPLIGA MARKER. [FAVOR ASPEN ON SUITABLE SITES!] Skogsagaren 21(3; 4): 42-4; 63-6. [Sw.]
Brief semi-popular article on aspen-growing for the match industry.

228.0

Kaldy, J. 1962. [THE ROLE OF ASPEN IN THE INCREASE OF WOOD PRODUCTION OF OUR FORESTS.] Erdeszettud. Kozl., Sopron 1962 (1): 97-120. 10 refs. [Hu.hu.russ.g.]

228.125

Gevorkiantz, S. R., Rudolf, P. O., and Zehngraff, P. J. 1943. A TREE CLASSIFICATION FOR ASPEN, JACK PINE, AND SECOND-GROWTH RED PINE. J. For. 41(4): 268-74. Bblg.

228.3

Smirnov, N. T., and Rjazanova, L. V. 1961. OSINOVO-LIPOVYE NASAZDENIJA LESOSTEPNOGO PRAVOBEREZ JA SARATOVSKOJ OBLASTI I PUTI IH ULUCSENIJA. [ASPEN/LIME STANDS IN THE FOREST-STEPPE OF THE SARATOV REGION, AND WAYS OF IMPROVING THEM.] Lesn. Z. Arhangel'sk 4(3): 37-42. 6 refs. [Russ.]
Presents stand measurements (b.a., height, volume, increment, and extent of decay) and makes recommendations on management.

23 REGENERATION AND FORMATION OF STANDS

Gese, E. C., and Shadle, A. R. 1943. REFORESTATION OF ASPEN AFTER COMPLETE CUTTING BY BEAVERS. J. Wildlife Mgmt. 7(2): 223-8. Bblg.

231 NATURAL REGENERATION

Borset, O. 1950. PROFERYAGELUE AV ASP VED NATURLIG BESANING. [REGENERATION OF ASPEN BY NATURAL SEEDING.] Tidsskr. Skogbr. 58(1/3): 8-13. 4 refs. [Nor.]
Describes three examples of natural regeneration by seeding in 1948. In one area, there were 110 seedlings in a square 50 × 50 cm.

231.5

Borset, O. 1956. ROTSKUDD HOS OSP. [ASPEN SUCKERS.] Tidsskr. Skogbr. 64(4): 219-40. 15 refs. [Nor.e.]

Guscin, I. I. 1959. NEKOTORYE DANNYE O VOZNIKNOVENII I OTPADE POROSLEVYH RASTENIJ OSINY. [SOME DATA ON THE PRODUCTION AND MORTALITY OF ASPEN SUCKERS.] Lesn. Z., Arhangel'sk 2(5): 35-7. [Russ.]

Smirnov, V. V. 1959. VEGETATIVNOE RAZMNOZENIE OSINY V NAGORNOJ CASTI TELLERMANOVSKOJ ROSCI. [VEGETATIVE REGENERATION OF ASPEN IN THE UPLAND PART OF THE TELLERMAN FOREST.] Trud. Inst. Les. No. 40: 5-52. 44 refs. [Russ.russ.]

232 ARTIFICIAL REGENERATION

Johnsson, H. 1942. GENERATIV OCH VEGETATIV FOROKNING AV POPULUS TREMULA. [SEXUAL AND VEGETATIVE PROPAGATION OF POPULUS TREMULA.] Svensk Bot. Tidskr. 36(2/3): 177-99. Bblg. [Sw.]

232.1

Baranski, S. 1954. HODOWLA SADZONEK OSIKI W SZKOLCO PODSIAKOWEJ [PODCIEKOWEJ]. [REARING ASPEN PLANTS IN AN IRRIGATED NURSERY.] Las Polski, Warsz. 28(5): 10-2. [Pol.]
From abstr. in Prehl. Lesn. Lit. 5(9): 3541. 1954. [Cz.]

Billik, R. 1954. MOJE DOSWIADSZENIE Z ZAKRESU POZYSKIWANIA NASION I HODOWLI SADZONEK OSIKI. [MY EXPERIENCE IN HARVESTING THE SEED AND REARING PLANTS OF POPULUS TREMULA.] Las Polski, Warsz. 28(5): 1-10. [Pol.]
From abstr. in Prehl. Lesn. Lit. 5(9): 3560. 1954. [Cz.]

Borset, O. 1954. OSPOFROETS SPIRECVNE. [THE GERMINATIVE CAPACITY OF ASPEN.] Medd. Norske Skogforsoksv. 13(1), (No. 44): 1-44. 13 refs. [Nor.nor.e.]

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Lotbiniere, H. G. J. de. 1935. ASPEN POPLAR (POPULUS TREMULA): MOST SUITABLE VARIETIES TO PLANT. Quart. J. For. 29: 19-25.

Marcet, E. 1957. ZUR AUFBEWAHRUNG VON ASPENSAMEN. [STORING ASPEN SEEDS.] Schweiz. Z. Forstw. 108(4/5): 270-3. 7 refs. [G.f.]
Seed from a 25-year-old aspen was stored in a partial vacuum (25 mm. Hg) at 2-3° C., (1) with, and (2) without seed-coat, and tested (a) for germinative capacity and (b) ability to reach the pricking-out stage (development of primary leaf). After 2 years (a) was still 98% for (1), 79% for (2), while (b) was 79 and 60% respectively. Controls stored at room temperature had lost all viability after 6 months, though (2) kept a little better than (1). The importance of (b) as a criterion is stressed.

Mathey. 1925. ON P. TREMULA IN FRANCE. Bull. Com. For., Paris 28: 351.

Munch, E. [Ed. Huber, B.] [1949?] BEITRAGE ZUR FORSTPFLANZENZUCHTUNG. VERSUCHE EINER AUSLESEZUCHTUNG DURCH EINZELSTAMM-ABSAATEN BEI FICHTE. WEITERE BEITRAGE ZUR FORSTPFLANZENZUCHTUNG AUS DEM WISSENSCHAFTLICHEN NACHLASS VON UNIV.-PROF. DR. ERNST MUNCH. [CONTRIBUTIONS TO FOREST TREE BREEDING SELECTION TRIALS OF PROGENY OF INDIVIDUAL SPRUCE TREES. FURTHER CONTRIBUTIONS TO FOREST TREE BREEDING FROM THE PAPERS OF THE LATE DR. E. MUNCH.] Bayerischer Landwirtschaftsverlag G.M.B.H., Munich. 116 pp. [G.]

Pospisil, J. 1951. JAK ZISKAME CISTE OSIKOVE SEMENO. [HOW TO OBTAIN CLEAN ASPEN SEEDS.] Csl. Les. 31(18): 593-4. [Cz.]

Schonbach, H. 1961. ERGEBNISSE EINES ANBAUVERSUCHES MIT ASPE (POPULUS TREMULA L.) AUF GLEYARTIGEM BODEN. [RESULTS OF A CULTIVATION TRIAL WITH P. TREMULA ON A PSEUDOGLEY SOIL.] Arch. Forstw. 10(2): 150-70. 3 refs. [G.g.russ.e.]

232.13

Barnes, B. V. 1958. ERSTE AUFNAHME EINES SECHSJAHRIGEN BESTANDES VON ASPENHYBRIDEN. [PRELIMINARY DATA FROM A 6-YEAR-OLD STAND OF ASPEN HYBRIDS.] Silvae Genet. 7(3): 98-102. 14 refs. [G.g.e.f.]

Flordh, S. 1954. STUDIER AV NAGRA F_2-POPULATIONER AV HYBRIDASP. [STUDIES ON SOME F_2 POPULATIONS OF HYBRID ASPEN.] Svenska SkogsvForen. Tidskr. 52(3): 287-98. 6 refs. [Sw.]

Haugberg, M. 1954. NOEN RESULTATER FRA AVKOMMFORSOK MED ASP. [SOME RESULTS OF PROGENY TRIALS WITH ASPEN.] Norsk Skogind. 8(5): 180-5. 3 refs. [Nor.nor.e.]

Johnsson, H. 1952. HYBRIDASPEN OCH DESS ODLING. [POPULUS TREMULA × TREMULOIDES AND ITS CULTIVATION.] Skogen 39(3/3): 68-70. [Sw.]
Gives figures showing its height growth, and discusses soil requirements, planting distances, growth when planted in mixed stands with spruce and regeneration from root suckers.

———— 1953. HYBRIDASPENS UNGDOMSUTVECKLING OCH ETT FORSOK TILL FRAMTIDSPROGNOS. [THE EARLY DEVELOPMENT OF HYBRID ASPEN AND AN ATTEMPT TO PREDICT ITS FURTHER GROWTH.] Svenska SkogsvForen. Tidskr. 51(1): 73-96. 11 refs. [Sw.]

———— 1957. AKTUELLT OM HYBRIDASP. [POPULUS TREMULA × P. TREMULOIDES TODAY.] Skogen 44(24): 798, 801. [Sw.]

Oskarsson, O. 1962. KOKEMUKSIA HYBRIDIHAAVAN VILJELYSTA. [EXPERIENCE WITH HYBRID ASPEN.] Metsat. Aikak. 1962(5/6): 205-7, 198. 3 refs. [Fi.e.]

232.3

Graumann. 1933. OBSERVATIONS AND EXPERIENCE WITH ASPEN SEEDS. Dtsch. Forstw. 15: 9-11.

Gray, W. G. 1949. THE RAISING OF ASPEN FROM SEED. For. Rec. For. Comm., Lond. No. 2, 7 pp.

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232.312

Wettstein, W. 1936. EXTRACTION OF ASPEN SEED. Forstwiss. Cbl. 53(21): 727-731. [G.]

232.32

Jirkovsky, V. 1954. ZKUSENOSTI S PESTOVANIM OSIKY ZE SEMENE. [RAISING ASPEN FROM SEED.] Lesn. Prace 33(7): 305-10. [Cz.]

Reim. 1930. RESEARCH PROPAGATION OF ASPEN IN FINLAND AND ESTONIA. Tartu For. Publ. (Estonia) 1.6. [G.]

Wettstein. 1931. PROPAGATION OF P. TREMULA AND OTHER SPECIES. Dtsch. Forstw. 13: 51.

232.323

Budke, A. 1952. SKUSENOSTI S PESTOVANIM OSIKOVYCH A BREZOVYCH SADENIC. [EXPERIENCE WITH THE REARING OF ASPEN AND BIRCH PLANTS.] Pol'ana 8(5): 80-1. [Slovak.]

Nemec, A. 1950. PESTOVANIE OSIKY ZO SEMENA. [RAISING ASPEN FROM SEED.] Pol'ana 6(12): 267-9. [Slovak.]

232.323.7

Marcet, E. 1954. UN PROCEDE POUR MIEUX REUSSIR LES SEMIS DE TREMBLE. [AN IMPROVED METHOD OF SOWING ASPEN [POPULUS TREMULA] SEED.] Schweiz. Z. Forstw. 105(11): 621-5. [F.g.]

232.325.2

Wolak, J. 1954. OBERWACJE NAD CHWASTAMI SZKOLKI OSIKOWEJ. [OBSERVATIONS ON WEEDS IN AN ASPEN NURSERY.] Sylwan 98(2): 144-8. 7 refs. [Pol.]
The weed species in an aspen nursery in Poland are listed and their effects on the seedling growth described. In unweeded soil the root system of seedlings is found at a greater depth than in weeded soil.

232.328

Frohlich, H. J. 1957. DIE VEGETATIVE VERMEHRUNG VON ASPE UND GRAUPAPPEL UND IHRE BEDEUTUNG FUR DEN WALDBAU. [VEGETATIVE PROPAGATION OF ASPEN AND GREY POPLAR AND ITS IMPORTANCE FOR SILVICULTURE.] Allg. Forstzeitschr. 12(14/15): 197-8. 3 refs. [G.]

Gullove, F. H. 1943. UBER DIE VEGETATIVE VERMEHRUNG VON POPULUS TREMULA L. [ON THE VEGETATIVE PROPAGATION OF POPULUS TREMULA L.] Zuchter 15(4/6): 101-4. Bblg. [G.]

Johnsson, M. 1941. MODERNA METODER FOR STICKLINGSFOROKNING. [MODERN METHODS OF PROPAGATION BY MEANS OF CUTTINGS.] Lustgarden, Stockh. 22: 35-40.

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232.328.1

Gancev, P. 1961. [PROPAGATION OF POPULUS TREMULA FROM DORMANT STEM CUTTINGS.] Gorsko Stopanstvo 17(12): 19-20. [Bulg.] From abstr. in Abstr. Bulg. Sci. Lit., Sofia 7(1): 206. 1962. [E.]
The cuttings are grafted on to P. przewalskii stocks, the point of union being in the ground. This prevents the P. tremula cuttings from rotting before they start to root.

Heitmuller, H. -H. 1954. VEGETATIVE VERMEHRUNG UNTER VERWENDUNG VON WUCHSSTOFFEN BEI POPULUS CANESCENS SMITH UND POPULUS TREMULA L. [VEGETATIVE PROPAGATION OF P. CANESCENS AND P. TREMULA WITH THE AID OF GROWTH REGULATORS.] Abstr. in Z. Forstgenet. 3(6): 135-6. [G.]

Thummler, K. 1957. UNTERSUCHUNGEN AUR VEGETATIVEN VERMEHRUNG VON POPULUS TREMULA L. DURCH GRUNSTECKLINGE MIT HILFE SYNTHETISCHER WUCHSSTOFFE. [THE PROPAGATION OF P. TREMULA BY SOFT CUTTINGS WITH THE HELP OF GROWTH REGULATORS.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 27 (Beitr. Pappelforsch. No. 2): 179-203. 17 refs. [G.g.]

232.328.1/2

Floor, J. 1952. PROEVEN MET VERMEERDERING DOOR ENTSTEKKEN. [TRIALS OF PROPAGATING BY 'x CUTTINGS' [CUTTINGS ASSISTED IN THE ROOTING PERIOD BY SIDE-GRAFTING TO CUTTINGS OF EASY ROOTERS].] Meded., Inst. Veredeling Tuinbouwgewassen, Wageningen No. 40, 26 pp. 11 refs. [Du.e.]

232.328.3

Larsen, C. M. 1943. STIKLINGER AF URTEAGTIGE SKUD PAA RODDER AF BAEVREASP OG GRAAPOPPEL. [CUTTINGS FROM HERBACEOUS SHOOTS ON ROOTS OF ASPEN AND GREY POPLAR.] Dansk Skovforen. Tidsskr. 28(3): 96-113. Bblg. [Dan.]

Zehngraff, P. J. 1946. SEASON OF CUTTING AFFECTS ASPEN SPROUTING. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 250, 1 p.

232.328.5

Gambi, G. 1959. PROMETTENTE RISULTATO DELL' IMNESTO DEL "POPULUS TREMULA" L. SU "POPULUS ALBA" L. [PROMISING RESULTS FROM THE GRAFTING OF P. TREMULA ON TO P. ALBA.] Monti e Boschi 10(12): 623-7. 3 refs. [It.f.e.]
On March 31, 1959, P. tremula scions were grafted on to 39 one-year rooted cuttings of P. alba. By July 3, 26 of the grafts had taken, with a mean scion shoot length of 1.2 m. Crown grafts were more successful than slit grafts.

Pospisil, J. 1958. O AFINITE MEZI OSIKOU P. TREMULA L. A NEKTERYMI DALSIMI JEDINCI RODU POPULUS. [ON THE AFFINITY BETWEEN POPULUS TREMULA AND SOME OTHER REPRESENTATIVES OF THE GENUS POPULUS.] Sborn. Csl. Akad. Zemed. Ved. (Lesn.) 4(11): 1005-16. 10 refs. [Cz.cz.russ.e.]

232.329.3

Solymos, R. 1960. A REZGONYAR CSEMETE TERMELES UJ MODSZEREI. [NEW METHODS OF RAISING ASPEN IN THE NURSERY.] Erdo 9(2): 68-71. [Hu.russ.g.]
Pricking out seedlings from cold frames at the maturing of the first cotyledon-pair has proved very successful. With two prickings out, plants can reach a mean height of 205 cm. vs. 120-130 cm. for only one, by the following autumn. When held all the year in the cold frame, heights of 180 cm. are reached (against 15-35 cm. in the open).

232.33

Wisniewski, J. 1954. PROBY SIEWU OSIKI W UPRAWACH. [TRIAL SOWING OF ASPEN IN PLANTATIONS.] Las Polski, Warsz. 28(5): 12-5. [Pol.]
From abstr. in Prehl. Lesn. Lit. 5(9): 3548. 1954. [Cz.]

232.4

Schwerin, v. 1919. PLANTING OF P. TREMULA. Mitt. Dtsch. Dendrol. Ges. 28: 168.

232.43

Domanski, W. 1954. SIEDLISKO I WZROST OSIKI. [THE SITE AND GROWTH OF ASPEN.] Las Polski, Warsz. 28(5): 16-7. [Pol.]
From abstr. in Prehl. Lesn. Lit. 5(10): 3852. 1954. [Cz.]

235.2/3

Leibundgut, H., and Kreutzer, K. 1958. UNTERSUCHUNGEN UBER DIE WURZELKONKURRENZ. 1. MITTEILUNG UBER DEN VORWALD. [INVESTIGATIONS ON ROOT COMPETITION. 1. ADVANCE PLANTINGS OF NURSE SPECIES.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 34(5): 361-98. 6 refs. [G.f.it.e.]

235.41

Kaldy, J. 1958. A REZGONYAR CSEMELENEVELESE ES JELENTOSEGE HEGYVIDEKI ERDEINKBEN. [PLANT PRODUCTION AND THE ROLE OF ASPEN IN OUR MOUNTAIN FORESTS.] Erdo 7(12): 446-55. 9 refs. [Hu.russ.g.]
Recommends the planting at 4×4 m. of aspen in beech and beech/oak stands at the thicket stage for felling later as a catch crop. A method of seed collection and plant raising, successfully followed for 4 years, is described.

24 TENDING OF STANDS AND TREES

Gevorkiantz, S. R., Rudolf, P. O., and Zehngraff, P. J. 1943. A TREE CLASSIFICATION FOR ASPEN, JACK PINE, AND SECOND-GROWTH RED PINE. J. For. 41(4): 268-74. Bblg.

[U.S.A.: Lake St. For. Exp. Sta.] 1935. TREATMENT OF ASPEN STANDS. U. S. For. Serv. Lake St. For. Exp. Sta., 5 pp.

242 THINNINGS

Bickerstaff, A. 1946. THE EFFECT OF THINNING UPON THE GROWTH AND YIELD OF ASPEN STANDS (FOR 10-YEAR PERIOD AFTER TREATMENT). PROJECT P-19. Silv. Res. Note Dom. For. Serv. No. 80, 25 pp. Bblg.

Sviridova, I. K. 1960. ROL' RUBOK UHODA V POVYSENII PLODOREDIJA LESNYH POCV. [ROLE OF TENDING OPERATIONS [THINNINGS] IN INCREASING THE FERTILITY OF FOREST SOILS.] Pocvoved. 1960 (4): 68-73. 4 refs. [Russ.russ.e.]

243 OPENING OF THE CANOPY (INCREMENT FELLING, OVERHEAD RELEASE AND IMPROVEMENT FELLINGS)

Lasch et al. 1881. TIME AND METHOD OF REMOVING POPLAR FROM CONIFER CROPS [P. TREMULANS]. Allg. Forst- u. Jagdztg. 57: 316-7.

25 TREATMENT OF DEFECTIVE, DERELICT OR VERY OPEN STANDS

Lefter, R., and Morosanu, O. 1960. INVAZIA PLOPOLUI, O FORMA NOUA DE DEGRADARE A PADURILOR DIN PODISUL SUCEVEI SI REFACEREA LOR. [THE ASPEN INVASION, A NEW FORM OF DEGRADATION IN THE FORESTS OF THE SUCEVEI PLATEAU, AND METHODS OF RESTORING THEM.] Rev. Padurilor 75(3): 145-9. 10 refs. [Rum.russ.g.f.e.]

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

32 FELLING AND RELATED OPERATIONS

Ankudinov, A. M. 1944. FAUTNOST' I METODY RATSIONAL'NOY RASKRYAZHEVKI OSINY. [DEFECTS AND METHODS OF RATIONAL CROSSCUTTING OF ASPEN.] Lesn. Prom. No. 9: 8-12. [Russ.]

332 CLEARING THE FELLING SITE

Sarkov, V. I. 1955. O HIMICESKOM SOSTAVE OTHODOV LESORAZRABOTOK. [CHEMICAL COMPOSITION OF LOGGING WASTE.] Gidrol. Lesohim. Prom. 8(7): 3-5. 3 refs. [Russ.]

34 STORAGE OF WOOD IN THE FOREST AND AT LOG DUMPS ("LANDINGS")

Hakkila, P. 1962. [ON THE SEASONING AND DECAY OF ASPEN PULPWOOD PREPARED IN SUMMERTIME.] Commun. Inst. For. Fenn. 54 (6). 34 pp. 13 refs. [Fi.e.e.] (Pienpuualan Toimikunnan Julkaisu No. 137.)
Aspen pulpwood was prepared monthly between July 1959 and Aug. 1960, and stacked for storage. Results show that barked and unbarked pulpwood keep equally well if stored for one or two summers, but barked wood keeps better by the third summer. Strip-barking and splitting gave increased decay. The durability of unbarked pulpwood increased with increasing length of bolt.

4 FOREST INJURIES AND PROTECTION

416.13

Kuster, E. 1952. CECIDOLOGISCHE NOTIZEN. V. UBER DAS ERINEUM VON POPULUS TREMULA. [CECIDOLOGICAL NOTES. V. ERINEUM POPULINUM ON P. TREMULA.] Flora, Jena 139(4): 540-5. 22 refs. [G.]
Notes on the character and formation of galls of E. populineum caused by the activity of Phyllocoptes populi on P. tremula.

416.3/5

Guscin, I. I. 1959. MORFOLOGICESKIE OSOBENNOSTI OSINOVYH MOLODNJAKOV PORAZENNYH SERDCEVINNOJ GNIL'JU. [MORPHOLOGICAL PECULIARITIES OF YOUNG ASPEN STANDS SUFFERING FROM HEART ROT.] Lesn. Hoz. 12(4): 27-9. [Russ.]

———— 1961. RASPROSTRANENIE KRASNINY PO DREVESINE STVOLIKA SEMENNOJ OSINY. [DISTRIBUTION OF RED STAIN IN THE STEM OF ASPEN GROWN FROM SEED.] Lesn. Z., Arhangel'sk 4(5): 47-50. [Russ.]

Mikalaikevicius (Mikalajkevicus), V. 1958. KAI KURIE DREBULINES PINTIES (PHELLINUS TREMULAE BOND. ET BORISS.) BIOLOGIJOS KLAUSIMAI. [ON THE BIOLOGY OF P. TREMULAE.] Liet. Misku Ukio Moksl. Tyr. Inst. Darb. No. 3: 187-203. 8 refs. [Lith.russ.]

———— 1959. LOZNYJOSINOVYJ TRUTOVIK V LESAH LITOVSKOJ SSR I NEKOTORYE EGO BIOLOGICESKIE OSOBENNOSTI. [PHELLINUS TREMULAE IN LITHUANIAN FORESTS, AND SOME OF ITS BIOLOGICAL FEATURES.] Dokl. Nauc. Konferencii po Zascite Rastenij, Vilnius 1958: 321-8. 6 refs. [Russ.russ.]

433 SALVAGE AND DISPOSAL OF FIRE-DAMAGED TIMBER

Ankudinov, A. M. 1939. O SERDTSEVINNOY GNILI OSINY. [ON HEARTWOOD ROT OF ASPEN.] Trud. Vsesoyuz. Nauchno-issledov. Inst. Lesnogo Khoz. 'VNIILKh' No. 2: 75-7. [Russ.]

441 FOREST WEEDS

Eliasson, L. 1963. THE TOXIC EFFECTS OF CHLORINATED PHENOXYACETIC ACIDS ON ASPEN. Physiol. Plant., Copenhagen 16(2): 255-68. 46 refs. [E.e.]

Hartig. 1885. P. TREMULA AS A PEST IN PINE AND LARCH WOODS. Allg. Forst- u. Jagdztg. 61: 326-7.

Lundberg, H. 1952. LOVROJNING MED FLYGPLANEN. [ERADICATING HARDWOODS FROM AIRCRAFT.] Skogen 39(11): 221-2, 234. [Sw].

443 FUNGI AND BACTERIA

Ankudinov, A. M. 1939. SERDTSEVINNAYA GNIL' OSINY I MERY BOR'BY S NEI. [HEARTROT OF ASPEN AND COMBATIVE MEASURES AGAINST IT.] Trud. Vsesoyuz. Nauchno-issledov. Inst. Lesnogo Khoz. 'VNIILKh' No. 7: 3-67. Bblg. [Russ.]

Ermilov, V. S. 1939. PRICHINY RAZVITIYA GNILI U OSINY I MERY BOR'BY S NEI. [THE CAUSES OF ROT DEVELOPMENT IN ASPEN AND COMBATIVE MEASURES.] Trud. Vsesoyuz. Nauchno-issledov. Inst. Lesnogo Khoz. 'VNIILKh' No. 7: 69-77. [Russ.]

Jorstad. 1928. DISEASES IN ASPEN. Tidsskr. Skogbr. 36: 436

[U.K.] 1951. [ASPEN AN ALTERNATIVE HOST TO PINE RUST.] Rep. For. Comm. Lond. 1949-50: 42.
A serious outbreak of Melampsora pinitorqua on Scots pine has pointed to the inadvisability of growing this species where aspen, the alternative host to the fungus, is present.

443.2

Kozlowska, C. 1961. BADANIA NAD ZWALCZANIEM GRZYBOW WYWOLUJACYCH ZGORZEL SIEWEK SOSNY I OSIKI. CZESC II. [INVESTIGATIONS ON THE CONTROL OF FUNGI CAUSING DAMPING-OFF IN SCOTS PINE AND ASPEN SEEDLINGS. PART II.] Prace Inst. Bad. Lesn. No. 212: 39-58. 37 refs. [Pol.russ.e.g.]

443.2/3

Rennerfelt, E. 1953. BIOLOGISCHE UNTERSUCHUNGEN UBER DEN KIEFERNDRCHER MELAMPSORA PINITORQUA (BRAUN) ROSTR. [BIOLOGICAL RESEARCH ON M. PINITORQUA.] [Pre-issue] Proc. Congr. Int. Union For. Res. Organ., Rome 1953, Section 24 (1/3). 5 pp. 3 refs. [G.]

443.3

Anderson, R. L., Joranson, P. N., and Einspahr, D. W. 1960. HYPOXYLON CANKER ON EUROPEAN ASPEN. U. S. Dep. Agric. Plant Dis. Reptr. 44(2): 132.
Cankers caused by Hypoxylon pruinatum were found on Populus tremula in Wisconsin. This is the first report of this disease on P. tremula in N. America or western Europe, though it has been reported from the U.S.S.R. In crossing with native species, P. tremula cannot be regarded as a source of resistance to H. pruinatum. [From authors' summary.]

Forsslund, K. -H. 1952. ASPBLADSMALEN, EN NY SKADEGORARE PA ASP. [DAMAGE TO ASPEN LEAVES BY LEUCOPTERA SINUELLA.] Skogen 39(6*/7*): 67*. [Sw.]

Ginzburg, M. 1961. BIOLOGIA I SZKODLIWOSC GRZYBA VENTURIA TREMULAE ADERH. W POLSCE. [BIOLOGY OF AND DAMAGE CAUSED BY THE FUNGUS V. TREMULAE IN POLAND.] Prace Inst. Bad. Lesn. No. 211: 3-37. 12 refs. [Pol.russ.e.g.]
An account of the biology of V. tremulae, and the extent and severity of the damage it causes to leaves and shoots. It is one of the most harmful parasites of aspen in Poland, especially in nurseries.

Hubbes, M. 1960. SYSTEMATISCHE UND PHYSIOLOGISCHE UNTERSUCHUNGEN AN VALSACEEN AUF WEIDEN. [SYSTEMATIC AND PHYSIOLOGICAL STUDIES ON VALSACEAE FROM WILLOWS.] Phytopath. Z. 39(1): 65-93. 50 refs. [G.g.e.]

Mikalaikevicius, V. 1959. KOVOS PRIEMONES SU CENTRINIU DREBULES PUVINIU. [CONTROL OF HEART ROT IN POPLARS.] Liet. Misku Ukio Moksl. Tyr. Inst. Moksl.-Tech. Inform. Biul. No. 1: 13-4. [Lith.]

Persson, A. 1962. [POPULUS TREMULA × P. TREMULOIDES AND VALSA NIVEA.] Skogen 49(24): 458-60. 3 refs. [Sw.]
Symptoms of the disease and its development in the field are described. Repeated experiments failed to establish it on unwounded branches. Inoculations in May or June gave much higher percentages of symptoms than those made later in the year, and those made on thin (3 mm. diam.) than those on thick (12 mm.) branches. Systematic studies begun in 1959 on different progenies of the hybrid have shown considerable variation between them as regards disease resistance.

Persson, E. 1955. KRONENMYKOSE DER HYBRIDASPE. I. UNTERSUCHUNGEN UBER AUFTRETEN, SELEKTIVE WIRKUNG UND PATHOGENITAT DES ERREGERS. [FUNGAL DIEBACK IN THE CROWNS OF HYBRID ASPENS. I. RESEARCH ON THE OCCURRENCE, SELECTIVE EFFECT AND PATHOGENICITY OF THE CAUSAL FUNGUS.] Phytopath. Z. 24(1): 55-72. 22 refs. [G.e.]

Pospisil, J. 1958. PROBLEM ZDRAVOTNIHO STAVU OSIKY. [THE HEALTH OF ASPEN [IN CZECHOSLOVAKIA].] Sborn. Csl. Akad. Zemed. (Lesn.) 4(10): 831-8. 14 refs. [Cz.cz.russ.g.]
Presents a diagram and table showing the proportion of healthy and diseased aspens in Bohemia, Moravia, and Slovakia. The fungus Phellinus igniarius f. tremulae causing heart rot, the most dangerous pathogen on aspen, is not very widespread, and resistant individuals still occur in the forest, although aspen had previously been removed as much as possible. These should be used for large-scale propagation.

Radzijevskyj, G. G. 1960. MALOVIDOMI GRYBY Z RODYNY POLYPORACEAE NA UKRAJINI. [LITTLE-KNOWN FUNGI OF THE FAMILY POLYPORACEAE IN THE UKRAINE.] Ukr. Bot. Z. 17(2): 107-8. 5 refs. [Ukr.]
Describes finds of Poria taxicola on fallen Pinus sylvestris twigs, Trametes trogii on living Populus tremula, and Polyporus borealis on rotten Picea abies stumps.

451.2

[U.S.S.R.: Soobsc. Inst. Les.] 1959. [ELK AND FORESTRY IN RUSSIA.] Soobsc. Inst. Les. No. 13. 58-110. Many refs. [Russ.]

453 INSECTS

Brammanis, L. 1963. [THE INCIDENCE AND CONTROL OF SAPERDA POPULNEA IN SWEDEN.] Z. Angew. Ent. 51(2): 122-9. 12 refs. [G.g.e.]

Forsslund, K. -H. 1952. ASPBLADSMALEN, EN NY SKADEGORARE PA ASP. [DAMAGE TO ASPEN LEAVES BY LEUCOPTERA SINUELLA.] Skogen 39(6*/7*): 67*. [Sw.]

Gabel, S. 1961. NEOSCIARA AMOENA WINN. ALS SCHADLING IN ASPENSTECKLINGSZUCHTEN. [N. AMOENA ATTACKING ASPEN CUTTINGS.] Anz. Schadlingsk. 34(6): 91. 3 refs. [G.]
N. amoena was found boring into the cambium of rooted aspen cuttings at the Hessische Forstliche Zuchtungsstation. The cambium and root hairs of rooted larch and birch cuttings were also attacked. Deaths occurred in all three species.

Georgijevic, E., and Vaclav, V. 1960. PRILOG POZNAVANJU STETNIH INSEKATA NA TOPOLAMA NR BOSNE I HERCEGOVINE. [INSECT PESTS OF POPLARS IN BOSNIA AND HERZEGOVINA.] Rad. Istraz. Topola Jugosl. Nac. Kom. Topolu No. 2: 47-53. [Serb.f.]

Kangas, E. 1940. ASPENS AVTORKNING BELYST AV ENTOMOLOGISKE ANALYSER. [ASPEN WILTING EXPLAINED BY ENTOMOLOGICAL INVESTIGATIONS.] Ent. Medd. 22(1): 32-4. Biol. Abstr. 17: 19233.

———— 1941. AGRILUS ATER L., ALS ESPENSCHADLING IN FINNLAND. [AGRILUS ATER L. AS A PEST OF ASPEN IN FINLAND.] Z. Angew. Ent. 28(2/3): 359-65. Bblg. [G.] Rev. Appl. Ent. A30: 245-6.

———— 1942. FORSTENTOMOLOGISCHE STUDIEN AN DER ESPE. [FOREST ENTOMOLOGICAL STUDIES ON ASPEN.] Ann. Ent. Fenn. 8(1): 49-71. Bblg. [G.]

———— 1955. BESCHREIBUNG EINER FINNISCHEN XYLETINUS-ART (COL., ANOBIIDAE). [DESCRIPTION OF A NEW FINNISH SPECIES OF XYLETINUS.] Ann. Ent. Fenn., Helsinki 21(1): 3-5. [G.]
The new species, named X. gronblomi, is found on Populus tremula.

Kudler, J. 1952. HROMADNY SKODLIVY VYSKYT TESARIKA [SAPERDA CARCHARIAS L.] NA OSIKACH NA HRONOVSKU. [MASS OUTBREAK OF S. CARCHARIAS ON ASPENS IN THE HRONOV DISTRICT.] Lesn. Prace 31(3): 122-5. [Cz.]

Nuorteva, P. 1961. PACHYPAPPELLA POPULI (L.) (HOM., PEMPHIGIDAE) AS A PEST OF POPULUS TREMULA (L.) IN FINLAND. Ann Ent. Fenn., Helsinki 27(3): 123-6. 3 refs. [E.e.]
Describes leaf injuries observed during the hot, dry summer o 1959 at Bromarf, S.W. Finland, mainly on older trees. Not onl leaves actually infested but others on the same twigs became dis colored and later dropped, defoliation reaching 5-30% from earl August onwards.

Pronin, J. 1935. ON THE BIOLOGICAL ROLE OF ASPEN IN FOREST ASSOCIATION. Ochr. Przyr. 15: 90-95. [Pol.g.] Rev. Appl. Ent. 24(11): 677. 1936.

Schefer-Immel, V. 1957. UBER EIN MASSENAUFTRETEN DER ZIKADE IDIOCERUS LAMINATUS FLOR. AN POPULUS TREMULA, MIT EINIGEN BEMERKUNGEN ZUR BIOLOGIE UND ZUM HONIGTAU DER ART. [AN OUTBREAK OF I. LAMINATUS ON P. TREMULA, WITH SOME OBSERVATIONS ON THE BIOLOGY OF THE SPECIES AND ON ITS HONEY DEW.] Anz. Schadlingsk. 30(10): 165-9. 19 refs. [G.]

———— 1958. EIN MASSENAUFTRETEN VON KATZCHENSCHADLINGEN AN ASPE (POPULUS TREMULA). [AN OUTBREAK OF CATKIN PESTS ON ASPEN.] Anz. Schadlingsk. 31(1): 7-10. 8 refs. [G.g.]

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Boyer, M. G. 1962. A LEAF-SPOTTING DISEASE OF HYBRID AND NATIVE ASPEN. Canad. J. Bot. 40(9): 1237-42. 3 refs.

5 FOREST MENSURATION

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

Sopp, L. 1961. A REZGONYAR (POPULUS TREMULA L.) FATOMEGES TORZSALAK-VIZSGALATAINAK EREDMENYEI. [WOOD VOLUME AND STEM FORM OF ASPEN.] Erdo 10 (7): 292-9. [Hu.russ.g.]

524.315

Borset, O. 1954. KUBERING AV OSP PA ROT. [DETERMINING THE VOLUME OF STANDING ASPEN.] Medd. Norske Skogforsoksv. 12(3) (43): 391-447. 25 refs. [Nor.nor.e.]
Gives volume tables for P. tremula in S. Norway based on measurement of 1,262 trees, showing volume. Volume can be found from a separate bark percent table. There is a full English summary and tables and graphs have English legends.

Ilvessalo, Y. 1947. PYSTYPUIDEN KUUTIOIMISTAULUKOT. [VOLUME TABLES FOR STANDING TIMBER.] Comm. Inst. For. Fenn. 34 (4): 1-149. 12 refs. [Fi.e.]

Rozenberg, V. A. 1952. OB'EMNYE TABLICY DLJA TAKSACII MOLODYH DREVOSTOEV. [VOLUME TABLES FOR YOUNG STANDS.] Lesn. Hoz. 5(6): 70-2. [Russ.]

Vincent, G., Korsun, F., and Zavadil, Z. 1950. POROSTNI A HMOTOVE TABULKY PRO TOPOLY. [YIELD AND VOLUME TABLES FOR POPLAR.] Lesn. Prace 29(5/6): 214-46. 9 refs. [Cz.cz.russ.f.]

525.1

Liogenkij, G. L. 1961. VYHOD BALANSA IZ OSINOVYH DREVOSTOEV. [PULPWOOD YIELD FROM ASPEN STANDS.] Lesn. Hoz. 14(10): 38-41. [Russ.]
Tabulates data on the pulpwood yields (three grades) from various age classes and site types, and on the age of technical maturity, for the aspen stands of the Vologda region, with particular reference to the production of sulphite pulp.

526.5

Borset, O. 1952. UNDERSOKELSER OVER OSPETOMMER. [INVESTIGATION ON ASPEN LOGS.] Medd. Norske Skogforsoksv. 11(2) (39): 355-423. 10 refs. (Nor.nor.e.]

531 CROWN DIMENSIONS, CROWN AREA, CROWN VOLUME, CROWN RATIO

Ievin, I. K., and Dikelson, E. O. 1962. MASSA KRON OSINY, BEREZY I ELI V KISLICNIKAH LATVII. [CROWN WEIGHT OF ASPEN, BIRCH AND SPRUCE IN OXALIS-TYPE STANDS IN LATVIA.] Lesn. Hoz. 15(4): 20-3. [Russ.]

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Avanzo, E. 1961(1962). ANALISI AUXOMETRICA DI UN IMPIANTO DI POPULUS TREMULA L. IN ABRUZZO. [INCREMENT OF A PLANTATION OF P. TREMULA IN THE ABRUZZI.] Pubbl. Cent. Sper. Agric. For., Roma 5: 263-71. 12 refs. [It.it.e.e.]
Measurement of a 42-year plantation showed a m.a.i. u.b. of 13.4 cu.m./ha. Mean height was 25.9 m., and mean d.b.h. 31.9 cm. On this basis, ca. 103 years is suggested as the rotation of maximum volume production.

Messeri, A. 1958(1959). APPUNTI SU UNA POPOLAZIONE DI POPULUS TREMULA L. DELLA SILA (CALABRIA). I. ANALISI AUXOMETRICA. [NOTES ON A STAND OF P. TREMULA AT SILA, CALABRIA. I. STEM ANALYSIS.] Pubbl. Cent. Sper. Agric. For., Roma 2: 23-42. 17 refs. [It.it.e.e.]

566 YIELD TABLES AND THEIR CONSTRUCTION

Haugberg, M. 1958. PRODUKSJONSOVERSIKTER FOR OSP: FORELOPIG RAPPORT. [YIELD TABLES FOR ASPEN: PRELIMINARY REPORT.] Medd. Norske Skogforsoksv. 15 (2) (50): 143-86. 17 refs. [Nor.nor.e.e.]
Presents tables based on material from 35 permanent sample plots for site classes II and III, and ages 18 to 70 years. It is emphasized that they are provisional and subject to correction when more material is available.

Mathiesen, A. 1949. ASPEN STANDS, THEIR GROWTH AND YIELD IN THE EXPERIMENTAL FOREST OF THE UNIVERSITY OF TARTU [ESTONIA]. Apophoreta Tartuensia, Stockh. 1949: 308-17. 13 refs. [E.]

Semeckin, I. V. 1959. HOD ROSTA NAIBOLEE RASPROSTRANENNYH ELOVO-LISTVENNYH DREVOSTOEV LENINGRADSKOJ OBLASTI. [YIELD TABLES FOR THE COMMONEST TYPES OF SPRUCE/HARDWOOD STANDS IN THE LENINGRAD REGION.] Lesn. Z., Arhangel'sk 2(5): 24-9. 3 refs. [Russ.]

Vincent, G., Korsun, F., and Zavadil, Z. 1950. POROSTNI A HMOTOVE TABULKY PRO TOPOLY. [YIELD AND VOLUME TABLES FOR POPLAR.] Lesn. Prace 29(5/6): 214-46. 9 refs. [Cz.cz.russ.f.]

567 STAND TABLES

Falaleev, E. N., and Danilin, M. A. 1962. [STRUCTURE OF THE POPULUS TREMULA STANDS OF SIBERIA.] Lesn. Hoz. 15(10): 12-4. [Russ.]
P. tremula stands occupy more than 7 million ha. in Siberia. Some data are tabulated on the distribution of stems by diameter classes in stands of different ages.

568 OTHER MENSURATIONAL STUDIES OF STAND CONSTITUTION AND CHANGES THEREIN. DISTRIBUTION OF GROWTH BY TREE CLASSES, ETC.

Tikka, P. S. 1954[1955]. HAAPAMETSIKOIDEN RAKENTEESTA JA LAADUSTA. I. RAKENNE. [STRUCTURE AND QUALITY OF ASPEN STANDS. I. STRUCTURE.] Commun. Inst. For. Fenn. 44(4). 33 pp. 41 refs. [Fi.e.]

———— 1956. HAAPAMETSIKOIDEN RAKENTEESTA JA LAADUSTA. II. LAATU. [STRUCTURE AND QUALITY OF ASPEN STANDS. II. QUALITY.] Commun. Inst. For. Fenn. 45(3). 54 pp. 26 refs. [Fi.e.e.]

6 FOREST MANAGEMENT

651.2

Jorgensen, F. 1952. PRISKOBLINGSBEREGNING FOR FYRSTIKVIRKE AV ASP. [PRICE CORRELATION CALCULATION FOR ASPEN MATCH TIMBER.] Medd. Norske Skogforsoksv. 11(3)(40): 569-618. 13 refs. [Nor.nor.e.]

651.71

Borset, O. 1953. OSPESKOGBRUKETS LONNSOMHET. [THE PROFITABILITY OF ASPEN.] Tidsskr. Skogbr. 61(4): 121-32. 10 refs. [Nor.]
On the basis of production figures for aspen in Norway and Sweden and of calculations on price relationships between spruce and aspen, it is concluded that at present prices in Norway, aspen is as profitable as spruce.

Jorgensen, F. 1956. DE OKONOMISKE BETINGELSER FOR LOVSKOGBRUKET I AGDERFYLKENE. [THE ECONOMIC CONDITIONS FOR GROWING HARDWOODS IN AGDER COUNTIES.] Norsk Skogbr. 2(22): 715-720. 5 refs. [Nor.]
Discusses potential markets and supplies, and estimates the relative profits and expenditure for spruce, aspen, and oak, concluding that aspen on good-quality sites can compete economically with spruce, but that oak is less likely to do so. Very little material for such calculations is, however, available and the results are not considered conclusive.

8 FOREST PRODUCTS AND THEIR UTILIZATION

811 STRUCTURE. IDENTIFICATION

Walek-Czernecka, A. 1952. ANATOMIA POROWNAWCZA DREWNA POPULUS ALBA L., POPULUS TREMULA L., POPULUS CANESCENS SM. [COMPARATIVE WOOD ANATOMY OF P. ALBA, P. TREMULA, AND P. CANESCENS.] Roczn. Dendrol. Polsk. Tow. Bot., Warsz. 8: 1-31. 21 refs. [Pol.russ.f.]

811.1

Hejnowicz, A., and Hejnowicz, Z. 1958. VARIATIONS OF LENGTH OF VESSEL MEMBERS AND FIBRES IN THE TRUNK OF POPULUS TREMULA L. Acta Soc. Bot. Polon. 27(1): 131-59. 32 refs. [E.e.]

811.12

Asunmaa, S. 1955. ELECTRON MICROSCOPE STUDIES ON SECTIONS OF ASPEN SULFITE PULP FIBRES. Svensk PappTidn. 58(2): 33-4. 5 refs. [E.g.sw.e.]
Results are shown in photomicrographs.

Huhrjanskaja, T. P. 1953. VLIJANIE PRESSOVANIJA NA STRUKTURU DREVESINY OSINY I SOSNY. [EFFECT OF COMPRESSION ON THE WOOD STRUCTURE OF ASPEN AND PINE.] Trud. Inst. Les. 9: 444-7.
X-ray spectra showed that the cellulose structure was the same in both species, and does not change until the volume is reduced by 40%. The cellulose is more orientated in late wood than in early. Compression increases the degree of orientation in pine wood irrespective of direction, while in aspen the change of orientation depends on the direction with regard to the direction of compression.

811.144

Weber, F. 1951. [STONE TYLOSES.] Phyton, Annales Rei Botanicae, Horn, N.-O. 3(1/2): 104-7. Transl. by U. von Koeppen and published as Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 2226. 1954. (Also Oxf. Transl. No. 1101.)
Stone tyloses were found around the larval chambers of Saperda populnea in Populus tremula and in vessels of part of a stem of Bauhinia sp.

811.156

Bruun, H. H., and Slungaard, S. 1957. INVESTIGATIONS OF POROUS WOOD AS PULP RAW MATERIAL. 1. FIBRE LENGTHS OF THE SPECIES ALNUS GLUTINOSA (L.) GAERTN., ALNUS INCANA (L.) MOENCH, BETULA VERRUCOSA EHRH. AND POPULUS TREMULA L. Pap. ja Puu 39(11): 521-5. 38 refs. [E.e.fi.sw.g.]

Scaramuzzi, G. 1962. WOOD FIBRE DIMENSIONS OF SOME ITALIAN PROVENANCES OF POPULUS TREMULA. Proc., 13th Congr. Int. Union For. Res. Organ., Vienna 1961, Pt. 2(2), Sect. 41/13. 11 pp. 16 refs. [E.e.]
Presents data on two provenances from Calabria, one from Sicily and one from Abruzzo, with some comparative data from black poplar hybrids. The morphology of the fibres is discussed in a paper-making context and the wood considered suitable for certain uses.

812 PHYSICAL AND MECHANICAL PROPERTIES

Hursudjan, P. A. 1960. FIZIKO-MEHANICESKIE SVOJSTVA DREVESINY OSINY, PROIZRASTAJUSCEJ V ARMENII. [THE PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF ASPEN GROWING IN ARMENIA.] Izv. Akad. Nauk Armjansk. SSR (Biol. Nauki), Ereven 13(9): 51-60. 16 refs. [Russ.arm.]
Gives tabulated data relating to one specimen of Populus tremula.

Jukna, A. D., and Tyltins, K. K. 1956. FIZIKO-MEHANICESKIE SVOJSTVA OSINY (POPULUS TREMULA L.) PROIZRASTAJUSCEJ V USLOVIJAH LATIVIJSKOJ SSR. [PHYSICAL AND MECHANICAL PROPERTIES OF P. TREMULA GROWING IN LATVIA.] Trud. Inst. Lesohoz. Probl., Riga No. 10: 47-59. 13 refs. [Russ.russ.]
Tabulated in detail.

Kaldy, J. 1962. [DATA ON THE MECHANICAL AND PHYSICAL PROPERTIES OF POPULUS TREMULA.] Erdeszettud. Kozl., Sopron 1962 (2): 59-88. 8 refs. [Hu.russ.e.g.]

Lenz, O. 1956. LE BOIS DES PRINCIPAUX PEUPLIERS ET D'UN SAULE INDIGENES EN SUISSE. [THE WOOD OF THE CHIEF POPLARS AND OF A WILLOW NATIVE TO SWITZERLAND.] Mitt. Schweiz. Anst. Forstl. Versuchsw. 32(5): 203-27. 12 refs. [F.f.g.it.e.]

812.21

Curro, P. 1957. PHYSICAL CHARACTERISTICS OF THE WOOD OF POPULUS × EURAMERICANA (DODE) GUINIER '1 154' AND OF POPULUS TREMULA L. [Docum.] Int. Popiar Comm., 5th Sess. Wkg. Party on Exploitation and Utilization, Paris 1957 No. FAO/CIP/UT-2, 12 pp. 2 refs. [E.]

812.35

Callin, G. 1948. OM FLOTTNING AV BJORK OCH ASP. [THE FLOATING OF BIRCH AND ASPEN.] Norrlands SkogsvForb. Tidskr. 1948 (4): 321-79. 9 refs. [Sw.]

Tuovinen, A. 1961. KUORELLISTEN KOIVUPAPERIPUUNIPPUJEN UNIMISKYVYSTA. [THE BUOYANCY OF BUNDLES OF UNBARKED BIRCH PULPWOOD.] Tied., Metsateho, Helsinki No. 188, 29 pp. 2 refs. [Fi.e.e.]

812.7

Jalava, M. 1945. SUOMALAISEN MANNYN, KUUSEN, KOIVUN JA HAAVAN LUJUUSOMINAISUUKSISTA. [STRENGTH PROPERTIES OF FINNISH PINE, SPRUCE, BIRCH, AND ASPEN.] Comm. Inst. For. Fenn. 33(3): 1-66. [Fi.e.]

Venet, J. 1955. ESSAIS SUR LA RESISTANCE MECANIQUE DU BOIS DE PEUPLIER FAITS AU LABORATOIRE DE TECHNOLOGIE DE L'ECOLE NATIONALE DES EAUX ET FORETS. [TESTS OF THE MECHANICAL STRENGTH OF POPLAR WOOD MADE AT THE ECOLE DES EAUX ET FORETS, NANCY.] Annexe to [Pap.] 8th Sess. Int. Poplar Comm., Madrid 1955 No. FAO/CIP/75-B, pp. 9-12. [F.]
Gives the results of tests on P. deltoides ("carolinensis"), × P. regenerata, and P. tremula.

813.1

Aaltio, E. 1958. INVESTIGATIONS ON THE MODE OF COMBINATION OF LIGNIN IN WOOD, WITH SPECIAL REFERENCE TO ASPEN (POPULUS TREMULA) WOOD. Ann. Acad. Scientiarum Fennicae, Helsinki (Ser. A. II) No. 88, 58 pp. 92 refs. [E.e.]

813.11

Aaltio, E., and Roschier, R. H. 1954. LIGNIININ KEMIALLINEN SITOUTUMINEN HAAPAPUUSSA FUSKUROITUJEN BUTANOLI-VESIKEITTOJEN VALOSSA. [THE CHEMICAL COMBINATION OF LICNIN IN ASPEN WOOD WITH REFERENCE TO BUFFERED BUTANOL/WATER COOKS.] Pap. ja Puu 36(4a): 157-74. 41 refs. [Fi.e.]

Holmberg, B. 1947. ESPENHOLZER UND MERCAPTOSAUREN. (LIGNINUNTERSUCHUNGEN, XVII). [ASPEN WOODS AND MERCAPTO ACIDS. (LIGNIN RESEARCH, XVII).] Arkiv. For. Kemi, Mineralogi Och Geologi, Stockh. 24a(29): 1-11. 9 refs. [G.g.]

Larsson, A. 1943. SULPHITE WASTE LIQUORS. V. LIGNOSULFONIC ACIDS FROM WASTE LIQUORS OF SULFITE CORKS OF ASPEN WOOD. Svensk PappTidn. 46: 93-100. [G.] Chem. Abstr. 37: 3266.

Smith, D.C.C. 1955. P-HYDROXYBENZOATE GROUPS IN THE LIGNIN OF ASPEN (POPULUS TREMULA). J. Chem. Soc., July, pp. 2347-51.
The lignin contains p-hydroxybenzoate groups. They occur singly, involving aliphatic hydroxyl groups of the native lignin and account for about 10% of its weight. [*From author's summary.*]

813.15

Schoettler, J. R. 1954. THE ALKALI RESISTANCE OF THE PENTOSANS IN ASPENWOOD. Tappi 37(12): 686-94. 27 refs.

813.2

Larsson, S. E., and Selleby, L. 1960. ASPEN WOOD CONSTITUENTS. Svensk PappTidn. 63(18): 606-8. 7 refs. [E.e.sw.g.]

Perila, O. 1955. INVESTIGATIONS ON THE ETHEREAL EXTRACT OF ASPEN WOOD (POPULUS TREMULA). Suomen Kemistilehti, Helsinki 28B(3): 109-10. 4 refs. [E.]
The following were tentatively identified: a sitosterol glucoside, cerotic (hexacosanoic) acid, and lignoseric (tetracosanoic) acid.

———— 1956. SATURATED FATTY ACIDS OF STEM CELLS OF BIRCH (BETULA VERRUCOSA) AND ASPEN (POPULUS TREMULA). Ann. Acad. Scientiarum Fennicae, Helsinki (Ser. A II), No. 76, 49 pp. 88 refs. [E.e.]
Reviews literature on saturated fatty acids in other woods and on methods of analysis, and gives photomicrographs of sections showing the location of extractives soluble in diethyl ether as such but insoluble in diethyl ether as bismuth salts, mainly in the medullary rays of both species.

Wienhaus, H. 1953. EXTRAKTSTOFFE AUS ASPENHOLZ VON POPULUS TREMULA. [EXTRACTIVES FROM THE WOOD OF P. TREMULA.] Chem. Technik, Berlin 5(1): 24. [G.]
Analysis of the C_6H_6 and CH_3OH extracts of aspen sawdust showed that aspenwood contains a fatty oil resembling linseed oil, and extractives similar to tannins and phlobaphenes and containing free and combined sugars.

813.3

Weber. 1895. ASH ANALYSIS OF WOOD AND BARK OF P. TREMULATA. Allg. Forst- u. Jagdztg. 2: 209-19.

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Savina, A. V. 1939. VLIYANIE RUBOK UKHODA NA STROENIE DREVESINY OSINY. [INFLUENCE OF THINNING ON THE WOOD STRUCTURE OF ASPEN.] Trud. Vsesoyuz. Nauchno-issledov. Inst. Lesnogo Khoz. 'VNIILKh' No. 2: 56-68.
Translation by D. Armstrong, Inform. Serv., Council for Sci. and Indus. Res., Melbourne. 16 pp.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Jakowleff. 1932. UTILIZATION OF ASPEN TIMBER DAMAGED BY WOOD ROT. Forstl. Rundschau 5: 178.

83/86

Polubojarinov, O. I., and Civiksin, L. E. 1962. [THE UTILIZATION OF DEFECTIVE ASPEN.] Lesn. Prom. 1962(10): 21-2. 2 refs. [Russ.]
Tabulates data on the physical and mechanical properties of sound and decayed wood, and wetwood. The possibilities of using defective aspen wood in building, box-shook manufacture, pulping, chipboard, etc., are discussed, and some machines for removing decayed wood are described.

832.2

Korenev, N. I., and Margolin, S. S. 1954. IZGOTOVLENIE FANERY IZ OSINY NA BELKOVYH KLEJAH. [MANUFACTURE OF PLYWOOD FROM ASPEN WOOD WITH ALBUMIN GLUES.] Derev. Lesohim. Prom. 3 (10): 25-6. [Russ.]

832.3

Anonymous. 1945. ASPEN SOM TANDSTICKSVIRKE. [ASPEN AS A MATCH TIMBER.] Svenska SkogsvForen. Tidskr. 43(6): 479-87. [Sw.]

Goriany. 1893. P. TREMULA FOR MATCH MANUFACTURE. Rev. Eaux For. 32: 494.

835 INDUSTRIAL AND DOMESTIC WOODWARE (MANUFACTURE AND USE)

Paskovici, N. 1935. PLOPUL TREMURATOR CA MATERIE PRIMA PENTRU CONFECTIONAREA PALARIILOR. [ASPEN AS A RAW MATERIAL FOR HATS.] Rev. Padurilor 47(5): 366-75. [Rum.f.g.]

839 MISCELLANEOUS

Chevedaev, A. A. 1945. KLESHCHEVAYA BOLVANKA IZ NOVYKH POROD. [HAME BLANKS FROM NEW [SUBSTITUTE] WOODS.] Lesn. Prom. 1945(10/12): 10-1. [Russ.]

844.1

Gambogi, P. 1957. ALTERAZIONI CHROMATICHE IN LEGNO DI PIOPPO ABBATTUTO. [STAINS OCCURRING IN THE WOOD OF POPULUS TREMULA AFTER FELLING.] Ann. Sper. Agr. (n.s.) 11(4): lxxvii-xcvi. 33 refs. [It.it.e.]

844.2

Ryckova, A. G. 1958. O HIMICESKOM SOSTAVE GNILOJ DREVESINY BEREZY I OSINY. [THE CHEMICAL COMPOSITION OF DECAYED BIRCH AND ASPEN WOOD.] Z. Prikl. Him. 31(2): 265-73. 21 refs. [Russ. russ.]

844.47

Bjorkman, E. 1953. THE OCCURRENCE AND SIGNIFICANCE OF STORAGE DECAY IN BIRCH AND ASPEN WOOD WITH SPECIAL REFERENCE TO EXPERIMENTAL PREVENTIVE MEASURES. Skr. K. Skogshogsk., Stockh. No. 12/19: 53-90. 15 refs. [E.e.sw.]

Tuovinen, A. 1955. KOIVU- JA HAAPAPUUN PILAANTUMINEN. [DAMAGE TO BIRCH AND ASPEN WOOD.] Pap. ja Puu 37(2): 36-41. 5 pp. 8 refs. [Fi.e.] Reprinted as Tied., Metsateho, Helsinki No. 112. 1955.
A review of previous research, especially that by E. Bjorkman (see preceding reference).

848.4/5

Jazon, A. Ja. 1956. SOHRANENIE SPICECNOJ OSINY V LETNYH USLOVIJAH. [SUMMER STORAGE OF ASPEN LOGS FOR MATCH MANUFACTURE.] Trud. Inst. Lesohoz. Probl., Riga No. 10: 133-40. 20 refs. [Russ.russ.]
Bitumen emulsions applied to the ends of logs gave good protection against cracks and, with the addition of phenolic antiseptics, against fungi.

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Masirevic, D. 1958. OSOBINE I UPOTREBLJIVOST NASE TOPOLE ZA PROIZVODNJU CELULOZE III. JASIKA (POPULUS TREMULA L.) KAO SIROVINE ZA PROIZVODNJU SULFITNE CELULOZE ZA PAPIR I ZA DALJU HEMISKU PRERADU. [THE PROPERTIES AND POSSIBILITIES OF USING YUGOSLAVIAN POPLARS FOR CELLULOSE PRODUCTION III. P. TREMULA AS A RAW MATERIAL FOR SULPHITE PULP FOR PAPER AND FURTHER CHEMICAL PROCESSING.] Topola, Beograd No. 7: 595-603. [Serb.g.]

861.0

Masirevic, D. 1957. OSOVINE I UPOTREBLJIVOST NASE TOPOLE ZA PROIZVODNJU CELULOZE. II. JASIKA. [THE PROPERTIES AND POSSIBILITY OF USING YUGOSLAV POPLARS FOR CELLULOSE PRODUCTION. II. POPULUS TREMULA.] Topola, Beograd 1(2): 93-107. 3 refs. [Serb.g.]

Schach, von. 1888. NOTE ON SUITABILITY OF POPULUS (P. TREMULA) WOOD FOR PAPER MANUFACTURE. Allg. Forst- u. Jagdztg. 64: 372.

861.14

Bruun, H. H. 1958. INSTITUTET FOR TRAKEMI VID ABO AKADEMI: VERKSAMHETEN AREN 1955-57. [REPORT ON THE ACTIVITY OF THE INSTITUTE FOR WOOD CHEMISTRY, ABO AKADEMI, 1955-57.] Pap. ja Puu 40(4a): 137-40. [Sw.sw.fi.e.]
Subjects covered include the chemistry of bark of Alnus glutinosa and sulphate pulping of aspen, A. incana and A. glutinosa.

861.14/15

Vethe, A., Loras, V., and Loschbrandt, F. 1962. [TRIALS OF RECENT PULPING METHODS FOR HARDWOODS.] Norsk Skogind. 16 (11): 458-69. 7 refs. [Nor.e.]
Compares ease of pulping, and pulp yield and properties of Betula verrucosa, Populus tremula, and Alnus incana pulped by the sulphate and various sulphite processes. Results are given in graphs.

861.15

Kalistratov, G. A. 1960. PULP FROM ASPEN. Bumaznaja Promyslennost', Moskva 35(5): 12-4. [Russ.] From abstr. in Chem. Abstr. 54(22): 25807. 1960.

867.3

Ljamin, V. A. 1962. [GASIFICATION OF SMALL CHIPS OF VARIOUS MOISTURE CONTENT.] Gidrol. Lesohim. Prom. 15(8): 8-11. 7 refs. [Russ.russ.]
Gasification trials were made with small chips of 10-50% m.c. from aspen fuelwood containing 16% bark and 10% decayed wood (Fomes igniarius). Yields of liquid products fell with increasing chip m.c., while gas yield rose. A chip m.c. of 25% proved optimum, but chips of less than 25% m.c. could be used.

892.62

Sharkov, V. I., and Kalnina, V. N. 1940. OIL FROM THE BARK OF THE ASPEN. Lesokhim. Prom. 1940(7): 3-5. Bblg. [R.]

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

905.2

Kaldy, J. 1961. UJABB ADATOK A REZGONYAR KERDESHEZ. [RECENT CONTRIBUTIONS TO THE ASPEN PROBLEM.] Erdo 10(9): 391-401. 8 refs. [Hu.russ.g.]

P. TREMULOIDES

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

111.84

Marston, R. B. 1956. AIR MOVEMENT UNDER AN ASPEN FOREST AND ON AN ADJACENT OPENING. J. For. 54(7): 468-9. 3 refs.

116.12

Bay, R. R. 1958. FOREST TYPE AFFECTS SNOWPACK. J. Soil Wat. Conserv. 13(3): 129-30.

———— 1960. SOIL FREEZING OBSERVATIONS AFTER CHANGES IN FOREST COVER. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 576, 2 pp.

116.2

Croft, A. R. 1950. A WATER COST OF RUNOFF CONTROL. J. Soil. Wat. Conserv. 5(1): 13-5.

Dunford, E. G., and Niederhof, C. H. 1944. INFLUENCE OF ASPEN, YOUNG LODGEPOLE PINE, AND OPEN GRASSLAND TYPES UPON FACTORS AFFECTING WATER YIELD. J. For. 42(9): 673-7. Bblg.

156 GAME MANAGEMENT. HUNTING AND SHOOTING

Hall, J. G. 1960. WILLOW AND ASPEN IN THE ECOLOGY OF BEAVER ON SAGEHEN CREEK, CALIFORNIA. Ecology 41(3): 484-94. 18 refs.

156.2

Lawrence, W. H. 1954. MICHIGAN BEAVER POPULATIONS AS INFLUENCED BY FIRE AND LOGGING. Abstr. of thesis, in Dissert. Abstr. 14(7): 1011-2. [Univ. Mich.]

Stegeman, L. C. 1954. THE PRODUCTION OF ASPEN AND ITS UTILIZATION BY BEAVER ON THE HUNTINGTON FOREST. J. Wildlife Mgmt. 18(3): 348-58. 11 refs.

Westell, C. E., Jr. 1954. AVAILABLE BROWSE FOLLOWING ASPEN LOGGING IN LOWER MICHIGAN. J. Wildlife Mgmt. 18(2): 266-71. 2 refs.

160.2

Euler, H. von, and Hahn, L. 1948. NUKLEINSAURE-GEHALT GRUNER BLATTER. I. [NUCLEIC ACID CONTENT OF GREEN LEAVES.] Arkiv For. Kemi, Mineralogi Och Geologi, Stockh. 258(1): 1-8. 11 refs. [G.g.]

160.22

Pearl, I. A., Darling, S. F., and Justman, O. 1962. STUDIES ON THE LEAVES OF THE FAMILY SALICACEAE. I. POPULIN FROM THE LEAVES OF POPULUS GRANDIDENTATA AND POPULUS TREMULOIDES. J. Organ. Chem. 27(7): 2685-7. 11 refs.

Pridham, J. B. 1960. OLIGOSACCHARIDES AND ASSOCIATED GLYCOSIDASES IN ASPEN TISSUES. Biochem. J. 76(1): 13-7. 43 refs.

160.29

Hubbes, M. 1962. TWO GLYCOSIDES FROM ASPEN FUNGISTATIC AGAINST HYPOXYLON PRUINATUM (KLOT.) CKE. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 18(6): 2-3.
The two additional fungistatic substances isolated from Populus tremuloides bark extracts are both glycosides. The highest co

centration of one occurred in the lower half of the crown, and of the other in the branch-free portion of the stem.

———— 1962. INHIBITION OF HYPOXYLON PRUINATUM BY PYROCATECHOL ISOLATED FROM BARK OF ASPEN. Science 136(3511): 156. 7 refs.

Mathes, M. C. 1963. ANTIMICROBIAL SUBSTANCES FROM ASPEN TISSUE GROWN IN VITRO. Science 140(3571): 1101-2. 16 refs.
Aspen tissue, originally isolated from the approximate cambial region of triploid stem sections, yielded substances producing inhibitory zones when the culture plates were inoculated with Fusiarium roseum, Saccharomyces cervisiae, Bacillus spp., Penicillium roqueforti, Torula utilis, Sarcina lutea, Flavobacterium aquatile, Pullularia pullulans, and Staphylococcus aureus.

161.19

Jensen, R. A., and Davis, J. R. 1955. SEASONAL MOISTURE VARIATIONS IN ASPEN. Minn. For. Note No. 19, 2 pp.
Investigations into the moisture content of living trees of Populus tremuloides in Minnesota showed that m.c. was at its lowest from June to Sept. inclusive, and high from Nov. to April inclusive, May and Oct. being transitional periods. There were also considerable variations between different parts of Minnesota.

161.2/3

Bourdeau, P. F. 1958. PHOTOSYNTHETIC AND RESPIRATORY RATES IN LEAVES OF MALE AND FEMALE QUAKING ASPENS. For. Sci. 4(4): 331-4. 7 refs.

161.32

Pearson, L. C., and Lawrence, D. B. 1958. PHOTOSYNTHESIS IN ASPEN BARK. Amer. J. Bot. 45(5): 383-7. 7 refs.

Strain, B. R., and Johnson, P. L. 1963. CORTICULAR PHOTOSYNTHESIS AND GROWTH IN POPULUS TREMULOIDES. Ecology 44(3): 581-4. 13 refs.

161.4

McDougall, G. A. 1963. RADIAL GROWTH STUDIES. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 19(3): 1. 2 refs.

161.6

Blake, G. M., Hossfeld, R. L., and Pauley, S. S. 1960. A TECHNIQUE FOR DETERMINING SEX FROM VEGETATIVE BUDS OF [SEXUALLY MATURE] QUAKING ASPEN. For. Sci. 6(4): 363-4.

Einspahr, D. W. [1962.] SEX RATIO IN QUAKING ASPEN AND POSSIBLE SEX-RELATED CHARACTERISTICS. Proc., 5th World For. Congr., Seattle 1960, Vol. 2 (Sect. 2): 747-50. 4 refs. [E.f.span.]
In a survey in natural stands of Populus tremuloides in Michigan and Wisconsin, in which nonflowering trees were girdled to produce flowers, the sex ratio did not differ significantly from 1/1. [Cf. Pauley and Mennel, below.] None of the characters studied differed significantly between the sexes over the whole area.

Pauley, S. S., and Mennel, G. F. 1957. SEX RATIO AND HERMAPHRODITISM IN A NATURAL POPULATION OF QUAKING ASPEN [POPULUS TREMULOIDES]. Minn. For. Note No. 55, 2 pp.
Analysis of the flowers of 206 trees in a native Minnesota population showed a sex ratio of 3 male: 1 female tree. Incidence of hermaphroditism in female trees was 20.6% and in male trees 4%. [Cf. Santamour, below.]

Santamour, F. S. 1956. HERMAPHRODITISM IN POPULUS. Proc., 3rd Ntheast. For. Tree Impr. Conf., Ithaca 1955: 28-30.
Examination of 10 catkins from each of some 600 trees (300 female and 354 male) of P. tremuloides, both wild and artificially bred, showed that ca. 48.7% of females bore some male flowers, and 2.8% of males some female flowers. These probably represent minimum figures since only 1 out of the 10 catkins from many trees showed abnormal flowers, and no doubt some of the apparently unisexual trees did in fact have both kinds.

161.9

Petrov, P. I. 1955. O TEMPERATURNOM REZIME DREVESNYH STVOLOV. [THE TEMPERATURE REGIME OF TREE STEMS.] Bot. Z. 40(4): 584-7. 3 refs. [Russ.]

164 MORPHOLOGY

Shope. 1928. STEM AND LEAF STRUCTURE OF ASPEN. Biol. Abstr. 2: 13389.

164.3

Day, M. W. 1944. THE ROOT SYSTEM OF ASPEN. Amer. Midl. Nat. 32(2): 502-9. Bblg.

164.4

Kaufert, F. 1937. FACTORS INFLUENCING THE FORMATION OF PERIDERM IS ASPEN. Amer. J. Bot. 24(1): 24-30.

164.6

Einspahr, D. W. 1960. ABNORMAL FLOWERING BEHAVIOR IN ASPEN. Iowa St. Coll. J. Sci. 34(4): 623-30. 15 refs.
Describes and illustrates branched staminate catkins and hermaphroditism in Populus tremuloides, and late flowering in P. grandidentata and P. tremuloides.

Erlanson and Hermann. 1930. MORPHOLOGY OF FLOWER IN P. TREMULOIDES. Biol. Abstr. 4: 12951.

Klaehn, F. U., and Neu, R. L. 1960. HARDWOOD POLLEN STUDY. Silvae Genet. 9(2): 44-8. 16 refs. [E.e.g.f.]

Nagaraj, M. 1952. FLORAL MORPHOLOGY OF POPULUS DELTOIDES AND P. TREMULOIDES. Bot. Gaz. 114(2): 222-43. 34 refs.

165.3

Joranson, P. N. 1959. IMPROVEMENT OF HARDWOODS THROUGH GENETICS. Tappi 42(8): 691-700. 37 refs.
A general review and discussion of the genetic approach in (mainly) Populus tremuloides production, with special reference to pulp and paper technology.

165.41

Barnes, B. V. 1958. ERSTE AUFNAHME EINES SECHSJAHRIGEN BESTANDES VON ASPENHYBRIDEN. [PRELIMINARY DATA FROM A SIX-YEAR-OLD STAND OF ASPEN HYBRIDS.] Silvae Genet. 7(3): 98-102. 14 refs. [G.g.e.f.]

Schonbach, H. 1960. EINIGE ERGEBNISSE ACHTJAHRIGER ZUCHTUNGSVERSUCHE MIT PAPPELARTEN DER SEKTION LEUCE. [SOME RESULTS OF EIGHT-YEAR-OLD BREEDING TRIALS WITH POPLAR VARIETIES OF THE SECTION LEUCE.] Wiss. Abh. Dtsch. Akad. LandwWiss., Berlin No. 44 (Beitr. Pappelforsch. No. 4): 7-21. 3 refs. [G.g. russ.e.]

165.42

Buijtenen, J. P. van, and Einspahr, D. W. 1959. NOTE ON THE PRESENCE OF SEX CHROMOSOMES IN POPULUS TREMULOIDES. Bot. Gaz. 121(1): 60-1. 8 refs.
Of 28 staminate individuals of P. tremuloides, 6 were found to have a heteromorphic chromosome pair, but a heteromorphic condition was not found in the others. It is unlikely, therefore, that the male sex in P. tremuloides is determined in this way.

———— Joranson, P. N., and Einspahr, D. W. 1958. NATURALLY OCCURRING TRIPLOID QUAKING ASPEN [POPULUS TREMULOIDES] IN THE UNITED STATES. Proc. Soc. Amer. For. 1957: 62-4. 12 refs.
An account of their discovery in several locations in the Lake States, 1956, of the methods used in searching for them and of the first data obtained on their morphology and fibre dimensions.

Einspahr, D. W., Buijtenen, J. P. van, and Peckham, J. R. 1963. NATURAL VARIATION AND HERITABILITY IN TRIPLOID ASPEN. Silvae Genet. 12(2): 51-8. 12 refs. [E.e.g.f.]

165.5

M.-Victorin. 1931. VARIATIONS OF P. TREMULOIDES AND P. GRANDIDENTATA. Bot. Cur. Lit. 13(7): 10.

165.52

Cottam, W. P. 1954. PREVERNAL LEAFING OF ASPEN IN UTAH MOUNTAINS. J. Arnold Arbor. 35(3): 239-50. 4 refs.

165.71

Barnes, B. V. 1961. HYBRID ASPENS IN THE LOWER PENINSULA OF MICHIGAN. Rhodora 63(755): 311-24. 18 refs.

Pauley, S. S. 1956. NATURAL HYBRIDIZATION OF THE ASPENS [POPULUS TREMULOIDES AND P. GRANDIDENTATA]. Minn. For. Note No. 47, 2 pp.

176.1

Guse. 1912. NOTES ON ASPEN. Allg. Forst- u. Jagdztg. 88: 376.

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Strothmann, R. O., and Zasada, Z. A. 1957. SILVICAL CHARACTERISTICS OF QUAKING ASPEN (POPULUS TERMULOIDES). U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 49, 26 pp. 91 refs.

Weigle and Frothingham. 1911. THE ASPENS. U. S. Dep. Agric. Bull. 93.

181.2

Farmer, R. E., Jr. 1963. EFFECT OF LIGHT INTENSITY ON GROWTH OF POPULUS TREMULOIDES CUTTINGS UNDER TWO TEMPERATURE REGIMES. Ecology 44(2): 409-11. 7 refs.

181.21

Buell, M. F., and Buell, H. F. 1959. ASPEN INVASION OF PRAIRIE. Bull. Torrey Bot. Cl. 86(4): 264-5. 2 refs.
A study of the root systems of aspen on prairie in Mahnomen County, Minn., suggests that, whereas in the past fire has kept the aspen groves reduced and the trees small, settlement and the practice of harvesting wild prairie hay has protected the groves and resulted in vigorous growth of aspen and of their long, propagating roots.

181.312

Croft, A. R., and Monninger, L. V. 1953. EVAPOTRANSPIRATION AND OTHER WATER LOSSES ON SOME ASPEN FOREST TYPES IN RELATION TO WATER AVAILABLE FOR STREAM FLOW. Trans. Amer. Geophys. Union 34(4): 563-74. 7 refs.

Marston, R. B., and Julander, O. 1961. PLANT COVER REDUCTIONS BY POCKET GOPHERS FOLLOWING EXPERIMENTAL REMOVAL OF ASPEN FROM A WATERSHED AREA IN UTAH. J. For. 59(2): 100-2. 5 refs.

[U.S.A.: Rocky Mt. For. Exp. Sta.] [1959.] ASPEN USES MORE WATER THAN SPRUCE OR GRASSLAND IN WESTERN COLORADO. Rep. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. 1958: 9.
The relative water use, determined in 1955 and 1957 by the difference in soil moisture content (to an 8-ft. depth) at the beginning and end of the growing season plus the amount of precipitation averaged 19.04 in. for aspen, 14.50 in. for spruce, and 9.78 in. for grassland. [Cf. Croft and Monninger, above.]

181.319

Bendtsen, B. A., and Rees, L. W. 1962. WATER-CONTENT VARIATION IN THE STANDING ASPEN TREE. For. Prod. J. 12(9): 426-8 2 refs.

181.32

Stoeckeler, J. H. 1948. THE GROWTH OF QUAKING ASPEN AS AFFECTED BY SOIL PROPERTIES AND FIRE. J. For. 46(10): 727-37. 17 refs.

181.343

Stoeckeler, J. H. 1961. ORGANIC LAYERS IN MINNESOTA ASPEN STANDS AND THEIR ROLE IN SOIL IMPROVEMENT. For. Sci. 7(1): 66-71. 15 refs.

181.36

Berndt, H. W., and Gibbons, R. D. 1958. ROOT DISTRIBUTION OF SOME NATIVE TREES AND UNDERSTORY PLANTS GROWING ON THREE SITES WITHIN PONDEROSA PINE WATERSHEDS IN COLORADO. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta., Sta. Pap. No. 37, 14 pp.

181.51

Sandberg, D., and Schneider, A. E. 1953. THE REGENERATION OF ASPEN BY SUCKERING. Minn. For. Note No. 24, 2 pp.
Summarizes the results of two studies: (1) on the phenomena of suckering in populus tremuloides, (2) on the conditions favoring the regeneration of P. tremuloides stands by suckering.

181.52

Ellison, L. 1943. A NATURAL SEEDLING OF WESTERN ASPEN. J. For. 41(10): 767-8.

Larson, G. C. 1944. MORE ON SEEDLINGS OF WESTERN ASPEN. J. For. 42(6): 452.

181.521

Einspahr, D. W., and Joranson, P. N. 1960. LATE FLOWERING IN ASPEN AND ITS RELATION TO NATURALLY OCCURRING HYBRIDS. For. Sci. 6(3): 221-4. 8 refs.
Reports, with illustrations, the flowering of male and female catkins of P. tremuloides 10 days later than the rest and providing thereby the necessary time bridge to explain local hybridization with P. grandidentata. [See Pauley, 1956, P. tremuloides, 165.71.]

Lester, D. T. 1963. FLORAL INITIATION AND DEVELOPMENT IN QUAKING ASPEN. For. Sci. 9(3): 323-9. 4 refs.

181.8

Marr, J. W. 1947. FROST INJURY TO ASPEN IN COLORADO. Abstr. in Bull. Ecol. Soc. Amer. 28(4): 60.

Smirnov, V. V. 1962. [THE SEASONAL GROWTH OF ASPEN.] Soobsc. Lab. Lesoved., Moskva No. 6: 94-111. 20 refs. [Russ.]

182 SYNECOLOGY. PLANT SOCIOLOGY

Baker. 1925. ASPEN IN CENTRAL ROCKY MOUNTAIN REGION. U. S. Dep. Agric. Bull. 1291.

Kittredge, J. 1938. THE INTERRELATIONS OF HABITAT, GROWTH RATE AND ASSOCIATED VEGETATION IN THE ASPEN COMMUNITY OF MINNESOTA AND WISCONSIN. Ecol. Monogr. 8: 151-246. Bblg.

182.3

Baker. 1918. ASPEN AS A TEMPORARY FOREST TYPE. J. For. 16: 294.

Fetherolf. 1917. ASPEN AS PERMANENT FOREST TYPE. J. For. 15: 757.

Gates. 1931. ASPEN ASSOCIATION IN N. LOWER MICHIGAN. Biol. Abstr. 5: 26767.

182.47

Ellison, L., and Houston, W. R. 1958. PRODUCTION OF HERBACEOUS VEGETATION IN OPENINGS AND UNDER CANOPIES OF WESTERN ASPEN [POPULUS TREMULOIDES]. Ecology 39(2): 337-45. 19 refs.
Heavier grazing by livestock in openings is believed to be responsible for the poorer production and species composition of the herbaceous vegetation commonly noted in openings than under the aspen canopy.

187 VEGETATION TYPES

Hoff, C. C. 1957. A COMPARISON OF SOIL, CLIMATE, AND BIOTA OF CONIFER AND ASPEN COMMUNITIES IN THE CENTRAL ROCKY MOUNTAINS. Amer. Midl. Nat. 58(1): 115-40. 12 refs.

187 X 164

Courtemanche, A. 1949. SPECTRE BIOLOGIQUE DU POPULETUM TREMULOIDIS DANS LE SUD-EST DU CANADA. [BIOLOGICAL SPECTRUM OF THE POPULETUM TREMULOIDES IN SOUTHEASTERN CANADA.] Ann de l'ACFAS, Montreal 15: 120-2. 7 refs. [F.]

Heinselman, M. L. 1954. THE EXTENT OF NATURAL CONVERSION TO OTHER SPECIES IN THE LAKE STATES ASPEN-BIRCH TYPE. J. For 52(10): 737-8.
Of the existing 19.5 million acres of aspen/birth, present trend indicate that, by 1990, 2.1 will have reverted to northern hard woods, 1.43 to spruce/fir, 0.75 to mixed types and 0.08 to pine Low value types will cover more than 1.0 million acres, 2.6 ar already partly converted to other types and 9.5 do not give muc promise of conversion in the foreseeable future.

187 X 165

Kagis, I. 1954. THE STORY OF A CUT-OVER. For. Chron. 30(2): 158-82. 4 refs.

187 X 424.72

Lynch, D. 1955. ECOLOGY OF THE ASPEN GROVELAND IN GLACIER COUNTY, MONTANA. Ecol. Monogr. 25(4): 321-44. 42 refs.

187 X 574/575

Bird, R. D. 1961. ECOLOGY OF THE ASPEN PARKLAND OF WESTERN CANADA IN RELATION TO LAND USE. Publ. Dep. Agric. Can. No. 1066, 155 pp. 200 refs.
An account of the original conditions, and changes in plant and animal ecology that have taken place since white settlement of the Prairie Provinces, as a result of hunting, fire, cultivation, etc. The aspen parkland lies between the great plains and the boreal forest; the land is in many places poorly drained and covered with small bodies of water; on the drier parts grassland and aspen-dominated forest are intermixed.

2 SILVICULTURE

[U.S.A.: Lake St. For. Exp. Sta.] 1931. GROWING BIGGER AND BETTER ASPEN. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes 52.

[U.S.A.: Paper Tr. J.] 1952. OVERCOMING THE THREAT TO ASPEN. Paper Tr. J. 135(1): 14.
A brief discussion of a research into the protection of aspen stands from invasion by maple and other hardwoods on good soil, and by oak on poorer soil (in Michigan).

22 SILVICULTURE SYSTEMS. CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Stock. 1933. SILVICULTURAL TREATMENT AND YIELD OF ASPEN. Dtsch. Forstw. 15: 289-99.

221.1

Reinke, M. E. 1955. MANAGEMENT OF ASPEN. Wis. Conserv. Bull. 20(11): 25-8.
Recommends clear felling for aspen (both bigtooth and trembling aspen) at maturity, which is reached in Wisconsin stands at ca. 40-50 years. Yields vary from 5 to 25 cords/acre depending on the soil moisture and fire history of the stand.

221.52

Logan, K. T. 1962. GROWTH OF WHITE PINE SEEDLINGS BENEATH AN ASPEN STAND. Tech. Note Dep. For. Can. No. 121, 13 pp. 9 refs.

228 CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Eyre. 1933. ASPEN COMPETITION IN NORWAY PINE PLANTATIONS. J. For. 31: 318.

[U.S.A.: Lake St. For. Exp. Sta.] 1930. GERMINATION AND SURVIVAL OF CONIFERS UNDER ASPEN. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 28.

228.11

Baldwin, H. I. 1949. GROWTH AND WEEVIL DAMAGE OF NORWAY SPRUCE GROWING UNDER ASPEN. Fox For. Notes No. 45, 1 p.

228.12

Cayford, J. H. 1957. INFLUENCE OF THE ASPEN OVERSTORY ON WHITE SPRUCE GROWTH IN SASKATCHEWAN. Tech. Note For. Br. Can. No. 58, 12 pp. 12 refs.

228.3

Kagis, I. 1952. SOME PROBLEMS OF MIXEDWOOD STANDS. For. Chron. 28(2): 6-18.

MacLeod, W. K., and Blyth, A. W. 1955. YIELD OF EVEN-AGED FULLY STOCKED SPRUCE-POPLAR STANDS IN NORTHERN ALBERTA. Tech. Note For. Br. Can. No. 18, 33 pp. 28 refs.
No growth data have previously been available for this important forest type (Picea glauca/Populus tremuloides). In spite of the difficulty of preparing yield tables for mixed stands, an attempt is made on the basis of 127 temporary sample plots, to provide tables suitable for the present stage of management in the area.

23 REGENERATION AND FORMATION OF STANDS

Baker. 1918. ASPEN REPRODUCTION AND MANAGEMENT. J. For. 16: 389.

231 NATURAL REGENERATION

Farrar, J. L., Gray, D. W., and Avery, D. 1954. JACKPINE REPRODUCTION. Pulp Paper Mag. Can. 55(12): 136-146. 16 refs.

231.5

Farmer, R. E., Jr. 1962. DEPTH AND DIAMETER OF THE PARENT ROOTS OF ASPEN ROOT SUCKERS. Mich. For. No. 23, 4 pp. 4 refs.
A study was made on Populus tremuloides (a) and P. grandidentata (b) root suckers. On the whole, (a) suckered nearer the soil surface and from smaller roots than (b) which occupies the whole A horizon more completely. This difference probably accounts for the advantage of (b) over (a) on shallow dry sites.

———— 1962. SOME PHYSIOLOGICAL ASPECTS OF ROOT SUCKER INITIATION AND EARLY GROWTH IN POPULUS TREMULOIDES AND P. GRANDIDENTATA. Abstr. of thesis, in Dissert. Abstr. 23(1): 10. [Univ. Mich.]

———— 1962. ASPEN ROOT SUCKER FORMATION AND APICAL DOMINANCE. For. Sci. 8(4): 403-10. 23 refs.

Larson, M. M. 1959. REGENERATING ASPEN BY SUCKERING IN THE SOUTHWEST. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. Res. Note No. 39, 2 pp. 1 ref.

Stoeckeler, J. H., and Macon, J. W. 1956. REGENERATION OF ASPEN CUTOVER AREAS IN NORTHERN WISCONSIN. J. For. 54(1): 13-6. 9 refs.

Strothmann, R. O., and Heinselman, M. L. 1957. FIVE-YEAR RESULTS IN AN ASPEN SUCKER DENSITY STUDY. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note 490, 2 pp.
At the Pike Bay Experimental Forest, Minn., survival and average height after 5 years were measured on 1/20-acre plots of 6-year aspen suckers with average densities of 260, 500, 1,000, 1,500 and a control of ca. 10,060 stems/acre. Plots for each stand density were replicated three times. Varying stand density had little effect on height growth. Survival decreased with increasing density. Suckering continues for 3 years if stands are thinned immediately after establishment.

[U.S.A.: Lake St. For. Exp. Sta.] [1951.] [DISKING TO STIMULATE ASPEN REPRODUCTION.] Rep. U. S. For. Serv. Lake St. For. Exp. Sta. 1950: 11-2.

Westell, C. E., Jr. 1961. THE ECOLOGY OF DEER AND ASPEN IN LOWER MICHIGAN. Abstr. of thesis, in Dissert. Abstr. 21(8): 2067-8. [Univ. Mich.]

Zillgitt, W. M. 1951. DISKING TO INCREASE STOCKING IN ASPEN STANDS. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 357, 1 p.

232.13

Stoeckeler, J. H., and Strothmann, R. O. 1955. EARLY DEVELOPMENT OF NATIVE AND HYBRID ASPENS. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 427, 1 p.
Survival and heights in their third and fourth year of 50 trees each of: Populus tremuloides (Mass.) × P. tremula (Munich); P. tremuloides (Wis.); and P. tremuloides (Mass.) × P. tremuloides (Colorado), grown on the Argonne Experimental Station, N.E. Wisconsin.

232.32

Einspahr, D. W. 1959. NURSERY PRODUCTION OF ASPEN SEEDLINGS. U. S. For. Serv. Tree Plant. Notes No. 35: 22-4. 1 ref.
Experiments indicate that seedlings of Populus tremuloides and P. grandidentata suitable for field planting can be obtained in one season by sowing in sterilized seedbeds covered with a layer of acid sand; daily watering and screening against rain drops are necessary until early July, when the screens are removed and watering done twice weekly.

232.323.5

Benson, M. K. 1962. IMPROVED METHOD FOR NURSERY PRODUCTION OF QUAKING ASPEN. [POPULUS TREMULOIDES] SEEDLINGS. U. S. For. Serv. Tree Plant. Notes No. 53: 11-3. 1 ref.
Trials were made to determine whether P. tremuloides seed must be actually on the surface of the soil in order to germinate and survive, as is generally believed. Experiments showed that it could be covered by as much as 1/8 in. of soil with little ill effect, and on this basis a new technique was evolved and is described.

232.328.1

Farmer, R. E., Jr. 1963. VEGETATIVE PROPAGATION OF ASPEN BY GREENWOOD CUTTINGS. J. For. 61(5): 385-6. 8 refs.

Snow, A. G. 1938. USE OF INDOLEBUTYRIC ACID TO STIMULATE THE ROOTING OF DORMANT ASPEN CUTTINGS. J. For. 36(6): 582-7. Bblg.

232.328.4

Chouinard, L. 1956. ESSAI DE MARCOTTAGE EN L'AIR DE BETULA PAPYRIFERA, POPULUS TREMULOIDES, LARIX LARICINA, ET ABIES BALSAMEA. [TRIALS OF AIRLAYERING WITH B. PAPYRIFERA, P. TREMULOIDES, L. LARICINA AND A. BALSAMEA.] Texte Conf. 36th Assembl. Ann. Corp. Ingen. For. Quebec 1956: 47-53. 9 refs. [F.]
Experiments were made on 18 trees each of the four species, two marcottes being made on each tree. Roots were formed in 5 cases in birch, 4 in poplar, 1 in larch and none in balsam fir.

———— and Parrot, L. 1958. THE CALLUSING AND ROOTING OF AIRLAYERS IN BETULA PAPYRIFERA, POPULUS TREMULOIDES, LARIX LARICINA AND ABIES BALSAMEA. Contr. Fonds Rech. For. Univ. Laval No. 2, 16 pp. 8 refs. [E.f.]

232.329.9

Einspahr, D. W., and Buijtenen, J. P. van. 1961. THE INFLUENCE OF GIBBERELLIC ACID ON GROWTH AND FIBER LENGTH OF QUAKING ASPEN. For. Sci. 7(1): 43-51. 9 refs.

234 FORMATION OF FOREST BY NATURAL SUCCESSION

Leisman, G. A. 1955. A VEGETATION AND SOIL CHRONOSEQUENCE ON THE MESABI IRON RANGE SPOIL BANKS, MINNESOTA. Abstr. of thesis, in Dissert. Abstr. 15(11): 1987-8. [Univ. Minn.]

———— 1957. A VEGETATION AND SOIL CHRONOSEQUENCE ON THE MESABI IRON RANGE SPOIL BANKS, MINNESOTA. Ecol. Monogr. 27(3): 221-45. 34 refs.

235.1

Logan, K. T., and Farrar, J. L. 1953. AN ATTEMPT TO GROW WHITE PINE [PINUS STROBUS] UNDER AN ASPEN [POPULUS TREMULOIDES] STAND. Silv. Leafl. For. Br. Can. 77, 3 pp.
Reexamination in 1950 of an experimental planting of white pine under aspen made in 1936, showed that it had been unsuccessful, owing to competition for light and rooting space. There were indications however that the shade from the aspen was beneficial in discouraging weevil attack on the pine.

Skilling, D. D. 1953. THE GROWTH OF UNDERPLANTED WHITE PINE. Mich. For. No. 2, 2 pp.
The high survival and good condition of a 21-year-old Pinus strobus stand, planted under an open hardwood stand on a dry sandy site is described (56% survival, mean ht. 7.1 ft.). Artificial release is not necessary, since release will occur naturally from the deterioration of aspen in the overstory.

Waldron, R. M. 1961. SEEDING WHITE SPRUCE AT THE BASE OF ASPEN. For. Chron. 37(3): 224-7, 233. 3 refs.
Three methods of sowing Picea glauca at the base of Populus tremuloides, (a) in the humus layer, (b) in moss, and (c) on scalped patches, were tested in dense young, and open mature, stands. Results indicated that (c) was more favorable than (a) or (b) for germination, and better for survival than scalped patches between trees.

242 THINNINGS

Day, M. W. 1958. THINNING ASPEN IN UPPER MICHIGAN. Quart. Bull. Mich. Agric. Exp. Sta. 41(2): 311-20.

Heinselmann, M. L. 1952. LABOR COSTS FOR THINNING YOUNG ASPEN. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 374, 1 p.
Results of thinning two stands, one at 11 and the other at 20 years showed that costs are much lower for the early thinning, even at compound interest. Later thinnings involve heavy axework.

———— 1954. THINNING FROM ABOVE REDUCES TOTAL YIELDS IN MEDIUM SITE ASPEN [POPULUS TREMULOIDES]. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 411, 1 p.
Summarizes the results of a study on a series of plots established in 1941 on 30-year-old medium quality aspen.

Herman, F. R. 1949. GROWTH OF ASPEN FOLLOWING PARTIAL CUTTING. U. S. For. Serv. Sthwest. For. Range Exp. Sta. Res. Notes No. 117, 3 pp.
Data on growth of Populus tremuloides in Arizona following partial cutting.

Pike, R. T. 1953. THINNING ASPEN, DUCK MOUNTAIN FOREST RESERVE, MANITOBA. PROJECT MS-5. Silv. Leafl. For. Br. Can. No. 89, 3 pp.
Tabulated results of observations over 20 years on three plots given different thinning treatments at 35 years.

243 OPENING OF THE CANOPY (INCREMENT FELLINGS, OVERHEAD RELEASE AND IMPROVEMENT FELLINGS)

Cooley, J. H., and Lord, W. B. 1958. A STUDY OF ASPEN-BALSAM FIR CUTTING METHODS IN NORTHERN WISCONSIN—FIVE-YEAR RESULTS. J. For. 56(10): 731-6. 11 refs.

Engle, L. G. 1949. CUTTING ASPEN OVERSTORY IMPROVES GROWTH OF YOUNG HARDWOODS. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 314, 1 p.

Steneker, G. A. 1963. RESULTS OF A 1936 RELEASE CUTTING TO FAVOUR WHITE SPRUCE IN A 50-YEAR-OLD WHITE-SPRUCE/ASPEN STAND IN MANITOBA. Publ. Dep. For. Can. No. 1005, 17 pp. 18 refs. [E.e.f.]

Stoeckeler, J. H. 1947. WHEN IS PLANTATION RELEASE MOST EFFECTIVE? J. For. 45(4): 265-71. Bblg.

243.8

Day, W. M. 1947. THE USE OF DINITRO PHENOL FOR THE CONTROL OF ASPEN. Quart. Bull. Mich. Agric. Exp. Sta. 30(2): 241-3. Bblg.

Quaite, J. 1953. POISONING WITH "AMMATE" TO ELIMINATE ASPEN [POPULUS TREMULOIDES]. Project A-13. Silv. Leafl. For. Br. Can. No. 94, 2 pp.
Stump treatment or notch treatment of living P. tremuloides with Ammate (NH_4 sulphamate) was effective in killing trees and preventing sprouting. Many untreated trees were killed through the connecting root system. Trees less than 1 in. d.b.h. were harder and more expensive to kill. The poison was more effective when applied in late summer or autumn.

Waldron, R. M. 1961. GIRDLING, BASAL SPRAYING AND FRILLING OF MATURE ASPEN. Timber of Canada 22(12): 34-5.

268.1

Sampson. 1919. EFFECT OF GRAZING ON ASPEN REPRODUCTION U. S. Dep. Agric. Bull. No. 741.

[U.S.A.: Rocky Mt. For. Range Exp. Sta.] [1947.] NET RAIN FALL AND SOIL MOISTURE UNDER ASPEN NOT AFFECTED BY CATTLE GRAZING. Rep. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. 1946: 33-4.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

31 LOGGING AND TRANSPORT: GENERAL

Schantz-Hansen, T. 1945. HARVESTING YOUNG ASPEN ON THE CLOQUET FOREST. J. For. 43(7): 506-7.

———— 1948. LOGGING METHODS AND PEELING OF ASPEN (POPULUS TREMULOIDES). U. S. For. Serv. Lake St. Aspen Rep. No. 3, 13 pp.

322.3

Panshin, A. J., Raphael, H. J., and Day, M. W. 1953. FURTHER OBSERVATIONS ON "CHEMICAL" BARK PEELING OF ASPEN. Quart. Bull. Mich. Agric. Exp. Sta. 35(4): 474-81.

Raphael, H. J. 1954. ANATOMICAL CHANGES IN TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.) INDUCED BY THE APPLICATION OF CHEMICAL AGENTS TO THE STEM. Quart. Bull. Mich. Agric. Exp. Sta. 37(2): 241-7. 5 refs.
The results of this study suggest that bark loosening is caused by a combination of chemical and physical changes occurring in the cambial region and adjacent tissues. The collapse of newly formed xylem cells and the accompanying lacunae, in conjunction with collapse and disintegration of cambial and phloem cells results in the formation of a belt of weakened material that can be ruptured very easily. Collapse of cells seems to be partially caused by a contraction of the whole phloem region.

———— Panshin, A. J., and Day, M. W. 1954. "CHEMICAL" BARK PEELING OF ASPEN, 1952 AND 1953 FIELD TESTS. Quart. Bull. Mich. Agric. Exp. Sta. 37(2): 230-40.

Shiue, C. -J., Brown, R. M., and Rees, L. W. 1958. ASPEN DEBARKING WITH 2,4,5-T. J. For. 56(7): 503-7. 10 refs.

378.44

Sonley, G. R. 1956. FLOTATION OF ASPEN. Pulp Paper Mag. Can. 57(2): 95-6. 1 ref. (Woodl. Sect. Index Canad. Pulp Pap. Ass. No. 1543 (B-9-b).)

4 FOREST INJURIES AND PROTECTION

Christensen, C. M., Anderson, R. L., Hodson, A. C., and Rudolf, P. O. 1951. ENEMIES OF ASPEN. U. S. For. Serv. Lake St. Aspen Rep. No. 22, 16 pp.
Enumerates, with brief descriptions, the damage caused to aspen by fungi, insects, mammals and birds, climatic factors and fire.

416.11

Barter, G. W., and Cameron, D. G. 1955. SOME EFFECTS OF DEFOLIATION BY THE FOREST TENT CATERPILLAR. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 11(6): 1.

Batzer, H. O., Hodson, A. C., and Schneider, A. E. 1954. PRELIMINARY RESULTS OF AN INQUIRY INTO EFFECTS OF DEFOLIATION OF ASPEN TREES BY THE FOREST TENT CATERPILLAR [MALACOSOMA DISSTRIA]. Minn. For. Note No. 31, 2 pp.
No tree was found whose death could be attributed solely to defoliation. In general the extent of crown dieback was directly related to vigor class, but appeared to be unaffected by stand age, density or site.

Condrashoff, S. F. 1958. DIFFERENCES IN ASPEN PHENOLOGY AND SURVIVAL OF IMMATURE STAGES OF PHYLLOCNISTIS POPULIELLA CHAMB. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 14(6): 3-4.

Dils, R. E., and Day, M. W. 1950. EFFECT OF DEFOLIATION UPON THE GROWTH OF ASPEN. Quart. Bull. Mich. Agric. Exp. Sta. 33(2): 111-3. 3 refs.

Duncan, D. P., and Hodson, A. C. 1958. INFLUENCE OF THE FOREST TENT CATERPILLAR UPON THE ASPEN FORESTS OF MINNESOTA. For. Sci. 4(1): 71-93. 14 refs.

———— Hodson, A. C., Schneider, A. E., and others. 1956. INFLUENCE OF THE FOREST TENT CATERPILLAR (MALACOSOMA DISSTRIA HBR.) UPON THE ASPEN FORESTS OF MINNESOTA. Office of Iron Range Resources and Rehabilitation, St. Paul, Minn. 45 pp. 10 refs.
Serious epidemics take place about once in 10 years. The effect of defoliation upon aspen [populus tremuloides] increment is likely to be a reduction of ca. 70% in the first year of a heavy defoliation, ca. 90% during the second, and ca. 15% during the year of recovery. The favorable effect of aspen and hazel defoliation on the coniferous regeneration in the understory is slight and temporary, since defoliation does not kill them.

Froelich, R., Hodson, A. C., Schneider, A. E., and Duncan, D. P. 1955. INFLUENCE OF ASPEN DEFOLIATION BY THE FOREST TENT CATERPILLAR IN MINNESOTA ON THE RADIAL GROWTH OF ASSOCIATED BALSAM FIR. Minn. For. Note No. 45, 2 pp. 2 refs.

———— Shiue, C. -J., Duncan, D. P., and Hodson, A. C. 1956. THE EFFECT OF RAINFALL ON THE BASAL AREA GROWTH OF ASPEN AS RELATED TO DEFOLIATION BY THE FOREST TENT CATERPILLAR [MALACOSOMA DISSTRIA]. Minn. For. Note No. 48, 2 pp.

Ghent, A. W. 1958. MORTALITY OF OVERSTORY TREMBLING ASPEN IN RELATION TO OUTBREAKS OF THE FOREST TENT CATERPILLAR [MALACOSOMA DISSTRIA] AND THE SPRUCE BUDWORM [CHORISTONEURA FUMIFERANA]. Ecology 39(2): 222-32. 9 refs.

Green, G. W., and Sullivan, C. R. 1950. ANTS ATTACKING LARVAE OF THE FOREST TENT CATERPILLAR, MALACOSOMA DISSTRIA HBN. (LEPIDOPTERA: LASIOCAMPIDAE). Canad. Ent. 82(9): 194-5.

Hildahl, V., and Reeks, W. A. 1960. OUTBREAKS OF THE FOREST TENT CATERPILLAR, MALACOSOMA DISSTRIA HBN., AND THEIR EFFECTS ON STANDS OF TREMBLING ASPEN IN MANITOBA AND SASKATCHEWAN. Canad. Ent. 92(3): 199-209. 14 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 571.)

Prentice, R. M. 1951. FURTHER NOTES ON THE LARGE ASPEN TORTRIX. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 7(5): 2.
Notes on the life history of Cacoecia (Archips) conflictana, a pest of Populus tremuloides in the Prairie Provinces.

Rose, A. H. 1958. THE EFFECT OF DEFOLIATION ON FOLIAGE PRODUCTION AND RADIAL GROWTH OF QUAKING ASPEN. For. Sci. 4(4): 335-42. 10 refs.

———— and Smereka, E. P. 1959. NOTES OF THE AMERICAN ASPEN BEETLE. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 15(3): 1.
Notes on life history and morphology of Gonioctena americana, a defoliator of Populus tremuloides.

Smereka, E. P. 1960. SOME NOTES ON LOBOPHORA NIVIGERATA WALKER. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 16(4): 1.
This is one of the more common geometrids found on aspen in the Cedar Lake area of N.W. Ontario in 1959. Notes are given on life history, parasites, etc.

416.13

Herdy, H. 1963. MELANAGROMYZA SCHINERI (GIRAUD) ON TREMBLING ASPEN IN ONTARIO. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 19(5): 2.
During 1961 and 1962 all stages of M. schineri were collected from galls on Populus tremuloides in Ontario, and the biology and behavior of the insect observed in detail, it is believed for the first time. It usually attacks young aspen reproduction less than 1 in. d.b.h. and 2-10 ft. high. In some stands, 14.6% of stems bore one or more galls.

416.15

Boyer, M. G. 1962. A LEAF-SPOTTING DISEASE OF HYBRID AND NATIVE ASPEN. Canad. J. Bot. 40(9): 1237-42. 3 refs.

Mielke, J. L. 1957. ASPEN LEAF BLIGHT IN THE INTERMOUNTAIN REGION. U. S. For. Serv. Intermt. For. Range Exp. Sta. Res. Note No. 42, 5 pp. 10 refs.
Notes on the distribution and hosts, epidemiology and symptoms of and damage caused by Marssonina populi which attacks the leaves and shoots of young Populus tremuloides trees.

Nordin, V. J. 1953. A LEAF-SPOT DISEASE OF ASPEN. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 9(2): 4.
A leaf-spot disease of Populus tremuloides has reached epidemic proportions in Alberta. The causal fungus has been identified as Marssonina tremuloidis.

416.17

[U.S.A.: Rocky Mt. For. Range Exp. Sta.] 1961. BROOMING OF NARROWLEAF COTTONWOOD [POPULUS ANGUSTIFOLIA] AND ASPEN [POPULUS TREMULOIDES] MAY RESULT FROM WINTER INJURY. Rep. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. 1960: 18.
Superficially the brooms resemble brooms of parasitic origin, but it is suspected that they are regrowths following the killing of the original branches by severe spring frost. Brooms on both species are characterized by unusually large leaves, e.g. 7 in. long on aspen vs. 2-3 in. for normal leaves.

416.3

Drouin, J. A., McLeod, B. B., and Wong, H. R. 1961. A ROUND-HEADED BOPER IN THE ROOT COLLAR OF POPLARS. Bi-m. Progr. Rep. For. Biol. Div. Dep. For. Can. 17(2): 2-3.
Populus tremuloides reproduction having a gnarled bulbous base are common in the Prince Albert area of Saskatchewan. Examination of affected trees disclosed extensive tunnelling in the heartwood of the root collars, apparently due to a Saperda sp. closely resembling S. calcarata.

416.3/5

Basham, J. T. 1958. DECAY OF TREMBLING ASPEN. Canad. J. Bot. 36: 491-505. 11 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 344.)

———— 1960. STUDIES IN FOREST PATHOLOGY. XXI. THE EFFECTS OF DECAY ON THE PRODUCTION OF TREMBLING ASPEN PULPWOOD IN THE UPPER PIC REGION OF ONTARIO. Publ. Dep. Agric. Can. No. 1060, 25 pp. 5 refs.

Black, R. L. 1951. POPLAR DECAY STUDY. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 7(2): 2.

———— 1953. RADULUM CASEARIUM, A POPLAR DECAY FUNGUS. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 9(4): 3.
A study of decay in Populus tremuloides in N. Ontario showed that R. casearium caused 20% of all cull losses from decay, and an even higher percent was found in Manitoba. Laboratory experiments with the fungus showed that optimum temperature for growth was 30° C. and optimum pH between 5.1 and 6.0. The fungus has never been found on balsam poplars and it is suggested that the pH of the sap of balsam poplars may be inhibitory to its growth.

Davidson, R. W., Hinds, T. E., and Hawksworth, F. G. 1959. DECAY OF ASPEN IN COLORADO. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta., Sta. Pap. No. 45, 14 pp. 10 refs.

Vanin, S. I., Bazenov, V. A., and Vihrov, V. E. 1953. O VLAZNOSTI ZDOROVOI I PORAZENNOI GRIBAMI DREVESINY V STVOLAH RASTUSCIH DEREVJEV. [MOISTURE CONTENT OF HEALTHY AND FUNGUS-INFECTED WOOD IN STEMS OF GROWING TREES.] Trud. Inst. Les. 9: 255-60. 2 refs. [Russ.]

416.4

Anderson, G. W. 1958. HYPOXYLON INFECTION NOT GREATLY INFLUENCED BY SEX OF ASPEN TREES. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 535, 1 p.
A survey of 495 aspens in N. Minnesota showed Hypoxylon canker to occur on both male and female trees, with a slightly higher level of infection for female trees.

Anderson, R. L. 1952. FACTORS INFLUENCING THE INCIDENCE OF HYPOXYLON CANKER OF ASPEN. Abstr. in Phytopathology 42(9): 463.

———— 1953. HYPOXYLON CANKER OF ASPEN IN THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 400, 1 p.
Correlations between incidence of canker and such factors as site quality and tree density are discussed. Practical conclusions are that stands on poor sites should be converted to species better adapted to such sites, and stands on better sites should be maintained at 70 percent full stocking and over.

———— 1955. HYPOXYLON [H. PRUINATUM] CANKER OF ASPEN. For. Pest Leafl. U. S. Dep. Agric. No. 6, 3 pp. 5 refs.

Andrews, S. R., and Eslyn, W. E. 1960. SOOTY-BARK CANKER OF ASPEN IN NEW MEXICO. U. S. Dep. Agric. Plant Dis. Reptr. 44(5): 373. 2 refs.
Cenangium singulare was found on Populus tremuloides on widely separated sites in 1959.

Davidson, R. W., and Cash, E. K. 1956. A CENANGIUM ASSOCIATED WITH SOOTY-BARK CANKER OF ASPEN. Phytopathology 46(1): 34-6. 6 refs.
Sooty bark canker of aspen (P. tremuloides) is here reported for the first time (in the Central Rocky Mts.). The bark becomes blackened but remains intact over the cankered area, which is found up to 60-70 ft. up the trunk. In 3-5 years a discomycete, here named Cenangium singulare (Rehm.) comb. nov. fruits abundantly in the canker. It may appear in the centres of the cankers before they girdle and kill the tree but it is most abundant in the diseased bark of dead trees.

———— and Hinds, T. E. 1956. HYPOXYLON CANKER OF ASPEN IN COLORADO. U. S. Dep. Agric. Plant Dis. Reptr. 40(2): 157-8. 6 refs.
Hypoxylon pruinatum on Populus tremuloides, reported for the first time in Colorado in 1955.

Day, M. W., and Strong, F. C. 1959. A STUDY OF HYPOXYLON [PRUINATUM] CANKER ON ASPEN [POPULUS TREMULOIDES]. Quart. Bull. Mich. Agric. Exp. Sta. 41(4): 870-7.

Graham, S. A., and Harrison, R. P. 1954. INSECT ATTACKS AND HYPOXYLON INFECTIONS IN ASPEN. J. For. 52(10): 741-3.
In ca. 95% of 138 Hypoxylon pruinatum cankers on the main stems of Populus tremuloides and P. grandidentata the original seat of infection was insect damage (Saperda calcarata 30%, Dicerca tenebrica 15, Agrilus 15, Lepidoptera 14). Silvicultural control is suggested.

Hinds, T. E. 1962. INOCULATIONS WITH THE SOOTY-BARK CANKER FUNGUS ON ASPEN. U. S. Dep. Agric. Plant Dis. Reptr. 46(1): 57-8. 2 refs.
Inoculation experiments on Populus tremuloides confirmed that Cenangium singulare is the cause of sooty-bark canker.

Shea, K. R., and Kuntz, J. E. 1955. EFFECTIVE INOCULATIONS OF ASPEN WITH HYPOXYLON PRUINATUM. Abstr. in Phytopathology 46(1): 26.

Stoeckeler, J. H. 1955. DEER, MICE AND HARES DAMAGE YOUNG ASPEN AND PAPER BIRCH PLANTINGS IN NORTHEASTERN WISCONSIN. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 441, 1 p.
Most of the loss in the first 3 years was due to girdling by Microtus pennsylvanicus.

[U.S.A.: Lake St. For. Exp. Sta.] 1959. [INSECT ATTACK ON ASPEN AND HYPOXYLON [PRUINATUM?].] Rep. U. S. For. Serv. Lake St. For. Exp. Sta. 1958: 38-9.

[U.S.A.: Rocky Mt. For. Exp. Sta.] [1962.] ASPEN CANKERS ARE WIDESPREAD BUT NOT ABUNDANT. Rep. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. 1961: 23-6.

Wood, F. A. 1962. A STUDY OF THE EPIPHYTOLOGY OF HYPOXYLON CANKER OF ASPEN. Abstr. of thesis, in Dissert. Abstr. 22(11): 3805. [Univ. Minn.]
Discusses the seasonal periodicity of canker growth, fungus development and ascopore ejection, the effect of bacteria on ascospore germination and its possible significance in nature, a

technique of inoculating stem sections and its use in studying natural infection, and the production of conidia by single ascospore lines.

———— and French, D. W. 1960. BACTERIA IN THE PERITHECIA OF HYPOXYLON PRUINATUM AND THEIR EFFECT ON ASCOSPORE GERMINATION AND DEVELOPMENT. Abstr. in Phytopathology 50(9): 659.

———— and French, D. W. 1962. EJECTION OF ASCOSPORES BY HYPOXYLON PRUINATUM IN MINNESOTA. Abstr. in Phytopathology 52(1): 33.

———— and French, D. W. 1963. CERATOCYSTIS FIMBRIATA, THE CAUSE OF A STEM CANKER OF QUAKING ASPEN. For. Sci. 9(2): 232-5. 7 refs.

416.4/5

Ewan, H. G. 1960. THE POPLAR BORER IN RELATION TO ASPEN STOCKING. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 580, 2 pp. 1 ref.

416.5

Davidson, R. W., and Hinds, T. E. 1958. UNUSUAL FUNGI ASSOCIATED WITH DECAY IN SOME FOREST TREES IN COLORADO. Phytopathology 48(4): 216-8. 4 refs.

Ethridge, D. E. 1961. FACTORS AFFECTING BRANCH INFECTION IN ASPEN. Canad. J. Bot. 39: 799-816. 8 refs. (Contr. For. Ent. Path. Br. Dep. For. Can. No. 724.)

———— and Laut, J. 1958. FUNGI ASSOCIATED WITH LIVING AND DEAD BRANCHES OF POLE-SIZED ASPEN. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 14(4): 2-3.

Hinds, T. E. 1963. EXTENT OF DECAY ASSOCIATED WITH FOMES IGNIARIUS SPOROPHORES IN COLORADO ASPEN. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. Res. Note No. RM-4, 4 pp. 7 refs.

McKay, H. H., and Lentz, P. L. 1960. DESCRIPTIONS OF SOME FUNGI ASSOCIATED WITH FOREST TREE DECAY IN COLORADO. Mycopathologia et Mycologia Applicata, Den Haag 13(4): 265-86. 26 refs. [E.e.]
Describes basidiocarps and cultures of four fungi already discussed, plus Peniophora rufa [on Populus tremuloides]. Picea engelmannii is reported as additional host for all three conifer fungi, and Pinus contorta for Helicobasidium corticoides.

Mikalajkevicjus [Mikalajkevicius], V. 1962. [SOME DATA ON THE INTERRELATIONSHIPS OF PHELLINUS TREMULAE AND P. IGNIARIUS F. BETULAE, AND COMPARATIVE INVESTIGATION OF THEIR SPORULATION.] In Botaniceskie Issledovanija No. 2. Institut Zoologii i Botaniki, Akademii Nauk Estonskoj SSR, Tartu. Pp. 201-10. 5 refs. [Russ.est.g.]

Riley, C. G. 1952. STUDIES IN FOREST PATHOLOGY. IX. FOMES IGNIARIUS DECAY OF POPLAR. Canad. J. Bot. 30(6): 710-34. 30 refs.

Silverborg, S. B. 1953. STERILE CONKS OF FOMES IGNIARIUS ON ASPEN. Phytopathology 43(12): 699-700.
Three sterile conks were found on recently killed, standing Populus tremuloides in New York State. The fungus was identified by cultural characteristics and by comparison with known isolates of F. igniarius from quaking aspen.

421.1

Ghent, A. W. 1958. MORTALITY OF OVERSTORY TREMBLING ASPEN IN RELATION TO OUTBREAKS OF THE FOREST TENT CATERPILLAR [MALACOSOMA DISSTRIA] AND THE SPRUCE BUDWORM [CHORISTONEURA FUMIFERANA]. Ecology 39(2): 222-32. 9 refs.

422.12

Egeberg, R., Jr. 1963. INHERENT VARIATIONS IN THE RESPONSE OF ASPEN [POPULUS TREMULOIDES] TO FROST DAMAGE. Ecology 44(1): 153-6. 13 refs.

Ouellette, G. B. 1963. FROST INJURIES ON BRANCHES OF ASPEN. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 19(5): 1.

44/45

Harrison, R. P., Jr. 1960. THE INSECTS AND DISEASES OF ASPEN. Abstr. of thesis, in Dissert. Abstr. 20(12): 4478-9. [Univ. Mich.]

441 FOREST WEEDS

Arend, J. L. 1953. SCRUB ASPEN CONTROL WITH BASAL SPRAYS. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 401, 1 p.
Tests in lower Michigan indicated that aspen suckering can be controlled successfully when the base of the tree is thoroughly wetted to a height of 2-3 ft. with a mixture of equal parts 2,4-D and 2,4,5-T esters in diesel oil (12 lb. acid to 100 gal. oil) applied after full leaf development in late June, July, and August.

Day, M. W. 1961. A TRIAL OF SEVERAL SILVICIDES ON RED MAPLE, ASPEN, AND WHITE PINE. Quart. Bull. Mich. Agric. Exp. Sta. 44(1): 27-31.

———— Hammer, C. L., and Panshin, A. J. 1952. PRELIMINARY OBSERVATIONS ON THE EFFECT OF 2,4-D AND 2,4,5-T ON ASPEN. Quart. Bull. Mich. Agric. Exp. Sta. 34(3): 266-74. 3 refs.

Shiue, C. -J. 1957. THE ANATOMICAL AND PHYSIOLOGICAL EFFECTS OF CHLOROPHENOXYACETIC ACID DERIVATIVES ON TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.) WITH SPECIAL REFERENCE TO THE APPLICATION OF SUCH CHEMICALS AS DEBARKING AGENTS. Abstr. of thesis, in Dissert. Abstr. 17(6): 1177. [Univ. Minn.]

———— Hossfeld, R. L., and Rees, L. W. 1958. ABSORPTION AND TRANSLOCATION OF 2,4,5-TRICHLOROPHENOXYACETIC ACID DERIVATIVES IN QUAKING ASPEN. For. Sci. 4(4): 319-24. 8 refs.

———— Rees, L. W., and Brown, R. M. 1958. SOME ANATOMICAL AND PHYSIOLOGICAL CHANGES IN QUAKING ASPEN [P. TREMULOIDES] INDUCED BY BARK REMOVAL WITH 2,4,5-T. For. Sci. 4(3): 212-8. 7 refs.

Worley, D. P., Bramble, W. C., and Byrnes, W. R. 1954. EFFECT OF SEASONAL BASAL SPRAYS ON ROOT SUCKERING OF ASPEN. Proc., 8th Ntheast. Weed Control Conf., pp. 447-52. 3 refs.

443 FUNGI AND BACTERIA

Brown, R. M. 1934. STATISTICAL ANALYSES FOR FINDING A SIMPLE METHOD FOR ESTIMATING THE PERCENTAGE HEART ROT IN MINNESOTA ASPEN. J. Agric. Res. Rep. 49(10): 929-42.

Gruenhagen, R. H. 1943. LIFE HISTORY OF HYPOXYLON PRUINATUM IN RELATION TO PATHOGENICITY ON ASPEN. Abstr. in Phytopathology 33(12): 1112.

———— 1945. HYPOXYLON PRUINATUM AND ITS PATHOGENESIS ON POPLAR. Phytopathology 35(1): 72-89. Bblg.

Hirt, R. R., and Hopp, H. 1942. RELATION OF TUBE LAYERS TO AGE IN SPOROPHORES OF FOMES IGNIARIUS ON ASPEN. Phytopathology 32(2): 176-8.

Horton, G. S., and Hendee, C. 1934. A STUDY OF ROT IN ASPEN ON THE CHIPPEWA NATIONAL FOREST. J. For. 32(4): 493-94.

Phelps, V. H. 1943. HEART ROT OF ASPEN. Silv. Leafl. Dom For. Serv. No. 18, 2 pp.

Seaver, F. J. 1945. SCLEROTINIA BIFRONS. Mycologia 37(6): 641-7.

443.3

Dance, B. W. 1961. SPORE DISPERSAL IN POLLACCIA RADIOSA (LIB.) BALD. AND CIF. Canad. J. Bot. 39(6): 1429-35. 3 refs.

Davidson, R. W., Hinds, T. E., and Hawksworth, F. G. 1959. DECAY OF ASPEN IN COLORADO. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta., Sta. Pap. No. 45, 14 pp. 10 refs.

French, D. W., and Oshima, N. 1959. HOST BARK CHARACTERISTICS AND INFECTION BY HYPOXYLON PRUINATUM (KLOT.) CKE. For. Sci. 5(3): 255-8. 1 ref.

Keener, P. D. 1953. UNUSUAL NUMBERS OF SPOROPHORES OF A WOOD-ROTTING FUNGUS ON TRUNKS OF POPULUS TREMULOIDES VAR. AUREA. U. S. Dep. Agric. Plant Dis. Reptr. 37(3): 164-5.
Presents counts of sporophores of Fomes igniarius in the San Francisco Mountains of Arizona, where they were observed in abnormal numbers on P. tremuloides var. aurea.

Marks, G. C., Berbee, J. G., and Riker, A. J. 1962. GLOEOSPORIUM SHOOT BLIGHT AND DEFOLIATION OF TREMBLING ASPEN. Abstr. in Phytopathology 52(8): 741-2.

Wall, R. E. 1962. EFFECTS OF EXTRACTS FROM DEAD BRANCHES OF TREMBLING ASPEN ON THE GERMINATION OF SPORES OF FOMES IGNIARIUS. Abstr. in Phytopathology 52(1): 31.

451 MAMMALS

Packard, F. M. 1942. WILDLIFE AND ASPEN IN ROCKY MT. NATIONAL PARK, COLORADO. Ecology 23(4): 478-82. Bblg.

451.2

Westell, C. E., Jr. 1956. ECOLOGICAL RELATIONSHIPS BETWEEN DEER AND FORESTS IN LOWER MICHIGAN. Proc. Soc. Amer. For. 1955: 130-2. 6 refs.
Summarizes the results of studies on the effect of deer browsing on aspen regeneration, and game management in Michigan.

453 INSECTS

Barter, G. W., and Brown, W. J. 1949. ON THE IDENTITY OF AGRILUS ANXIUS GORY AND SOME ALLIED SPECIES (COLEOPTERA: BUPRESTIDAE). Canad. Ent. 81(10): 245-9. (Contr. Div. Ent. Dep. Agric. Can. No. 2633.)

Graham, S. A., and Mason, R. R. 1958. INFLUENCE OF WEATHER ON POPLAR BORER [SAPERDA CALCARATA] NUMBERS. Mich. For. No. 20, 3 pp. 2 refs.
Confirms previous findings [cf. Graham and Harrison, 1954, P. tremuloides, 416.4] that precipitation has a definite influence on subsequent beetle populations. The effect of high temperatures was also noted: in the high nineties they cause beetle mortality that offsets the favorable effect of dry weather.

Henson, W. R. 1954. A SAMPLING SYSTEM FOR POPLAR INSECTS. Canad. J. Zool. 32: 421-33. 7 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 172.)

———— 1958. THE EFFECTS OF RADIATION ON THE HABITAT TEMPERATURES OF SOME POPLAR-INHABITING INSECTS. Canad. J. Zool. 36: 463-78. 10 refs.

Osgood, E. A., Jr. 1963. POPULATION DYNAMICS OF INSECTS ON SUCKERS OF QUAKING ASPEN, POPULUS TREMULOIDES MICHX., WITH SPECIAL EMPHASIS ON THE SPOTTED POPLAR APHID, APHIS MACULATAE OESTLUND, AND THE WILLOW SHOOT SAWFLY, JANUS ABBREVIATUS (SAY). Abstr. of thesis, in Dissert. Abstr. 24(1): 41-2. [Univ. Minn.]

Peterson, L. O. T. [n.d.] SOME ASPECTS OF POPLAR BORER, SAPERDA CALCARATA SAY, (CERAMBYCIDAE) INFESTATIONS UNDER PARKBELT CONDITIONS. Contrib. Div. Ent. Dep. Agric. Can. No. 2528, 6 pp.

Rose, A. H., and Smereka, E. P. 1959. INSECTS ON TREMBLING ASPEN [POPULUS TREMULOIDES]. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 15(2): 1-2.
A study is being conducted in N.W. Ontario. The most abundant species are Gonioctena americana, Rhabdophaga sp., Enargia decolor, Xylomyges dolosa, Epinotia nisella, and Sciaphila duplex.

Wong, H. R. 1957. SAWFLIES OF THE GENUS PLATYCAMPUS SCHIODTE ON TREMBLING ASPEN IN THE CANADIAN PRAIRIES. Bi-m. Progr. Rep. Div. For. Biol. Dep. Agric. Can. 13(4): 2.
Two species found feeding on the foliage of Populus tremuloides have been tentatively identified as Platycampus americanus and P. albostigmus.

5 FOREST MENSURATION

523.1

[U.S.A.: Cent. St. For. Exp. Sta.] [1948.] [BARK THICKNESS OF RED OAK AND ASPEN.] Rep. U. S. For. Serv. Cent. St. For. Exp. Sta. 1947: 26.

524.12

Stoehr, H. A. 1954. STAND CONDITIONS AFFECTING FORM FACTOR IN TREMBLING ASPEN. Abstr. of thesis, in Dissert. Abstr. 14(8): 1122. [Univ. Mich.]

———— 1955. STEM TAPER OF TREMBLING ASPEN. For. Sci. 1(3): 222-6. 12 refs.

524.314

Golding, D. L., and Hall, O. F. 1961. TESTS OF PRECISION OF CUBIC-FOOT TREE-VOLUME EQUATIONS. For. Chron. 37(2): 123-32.

524.315

MacLeod, W. K. 1952. AVERAGE DIAMETER, A BASIS FOR CRUISING SECOND GROWTH. Res. Note U.B.C. For. Club No. 6, 7 pp. 5 refs.

Peterson, G. 1961. VOLUME TABLES FOR ASPEN IN COLORADO. U. S. For. Serv. Rocky Mt. For. Range Exp. Sta. Res. Note No. 63, 4 pp. 2 refs.
Three gross vol. tables in 1-in. diam. classes giving bd.-ft. vol. to 6- and 8-in., and cu.-ft. vol. to 4-in. top diam. u.b., based on measurements of Populus tremuloides felled for a study of decay [see Davidson, Hinds, and Hawksworth, 1959, P. tremuloides, 443.3]. U.b.-o.b. diam. relationships were computed.

526 LOG MEASUREMENT. "SCALING"

Gevorkiantz, S. R., and Zehngraff, P. 1943. SCALING ASPEN BOLTS BY THE CORD. J. For. 41(6): 450-2.

532 QUANTITY AND AREA OF FOLIAGE

Henson, W. R. 1954. A SAMPLING SYSTEM FOR POPLAR INSECTS. Canad. J. Zool. 32: 421-33. 7 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 172.)

54 ASSESSMENT OF SITE QUALITY

Heinselman, M. L., and Zasada, Z. A. 1955. A REVIEW OF LITERATURE RELATING TO QUAKING ASPEN [POPULUS TREMULOIDES] SITES. U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 32, 61 pp. 92 refs.
Summarizes available data for Minnesota.

Lafond, A. 1956. LE RENDEMENT DE QUELQUES TYPES DE TREMBLE SUR LA COTE NORD. [THE YIELD OF VARIOUS TYPES OF ASPEN [STANDS] ON THE NORTH COAST [OF QUEBEC].] Abstr. in Ann. ACFAS 22: 54. [F.]
A study based on more than 450 sample plots and more than 800 stem analyses indicated that in three forest types examined, differences in the structure and composition of the vegetation corresponded to differences in yield of conifers or aspen, though total site productivity and site class was the same.

Losee, S. T. B. 1954. SITE CLASSIFICATION AT ABITIBI WOODLANDS LABORATORY. Pulp Pap. Mag. Can. 55(11): 168-174. (Woodl. Sect. Index Canad. Pulp Pap. Ass. No. 1404 (E-2).)
Using bases designed to cover silvicultural conditions generally as well as the probable performance of various species (ground cover and ht. growth of black spruce, jack pine, and aspen) gives a tentative table showing three levels of fertility and five of soil moisture. The seven sites so far determined are described in detail. Probably two more will follow.

Wilde, S. A., and Pronin, D. T. 1950. GROWTH OF TREMBLING ASPEN IN RELATION TO GROUND WATER AND SOIL ORGANIC MATTER. Proc. Soil Sci. Soc. Amer. 1949, Vol. 14: 345-7. 5 refs.

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Gevorkiantz, S. R. 1956. SITE INDEX CURVES FOR ASPEN IN THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Note No. 464, 2 pp. 1 ref.

Meyer, D. 1956. THE RELATION OF SOIL HORIZON TEXTURE AND ACIDITY TO THE SITE INDEX OF ASPEN IN NORTHERN MINNESOTA. Minn. For. Note No. 52, 2 pp. 1 ref.
A study involving 36 sample plots on sites varying greatly in

drainage, topography and climate, showed highly significant correlations between site index and the silt and clay content of B and C horizons, and between site index and pH of the C horizon (the latter being correlated with its silt and clay content).

Stoeckeler, J. H. 1956. SOIL FACTORS AFFECTING THE GROWTH OF QUAKING ASPEN FORESTS IN THE LAKE STATES. Abstr. of thesis, Univ. Minn., St. Paul. 3 pp.

———— 1960. SOIL FACTORS AFFECTING THE GROWTH OF QUAKING ASPEN FORESTS IN THE LAKE STATES. Tech. Bull. Minn. Agric. Exp. Sta. No. 233, 43 pp. 108 refs.

Strothmann, R. O. 1960. EVALUATING THE GROWTH POTENTIAL OF ASPEN LANDS IN NORTHERN MINNESOTA. U. S. For. Serv. Lake St. For. Exp. Sta., Sta. Pap. No. 86, 20 pp. 4 refs.

[U.S.A.: Lake St. For. Exp. Sta.] [1955.] SOME ASPEN SITE FACTOR RELATIONSHIPS DISCOVERED. Rep. U. S. For. Serv. Lake St. For. Exp. Sta. 1954: 12.

Voigt, G. K., Heinselman, M. L., and Zasada, Z. A. 1957. THE EFFECT OF SOIL CHARACTERISTICS ON THE GROWTH OF QUAKING ASPEN IN NORTHERN MINNESOTA. Proc. Soil Sci. Soc. Amer. 21(6): 649-52. 22 refs.

551 IN SINGLE TREES WITH ANNUAL RINGS

Kirby, C. L. 1953. ACCURACY OF RING COUNTS ON POPLAR. Silv. Leafl. For. Br. Can. No. 85, 2 pp.
Eighty-seven percent of ring counts in the field on 23 representative sample discs of P. tremuloides and P. balsamifera were below those made in the laboratory. This may be attributed to indistinct demarcation between early and late wood and to the presence of decay.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Downing, G. L. 1960. SOME SEASONAL GROWTH DATA FOR PAPER BIRCH, WHITE SPRUCE AND ASPEN NEAR FAIRBANKS, ALASKA—1958. Tech. Note Alaska For. Res. Cent. No. 46, 3 pp. 1 ref.
Birch leader growth started in late May and continued til early July (43-47 days). Radial growth of all three species started in early June and ended in mid-July. Mean leader growth per tree (birch) was 4.70 in. at Richardson Highway (a) and 0.82 in. at Elliott Highway (b). Mean total radial growth at (a) was: birch 1.012 in., spruce 0.028 in., and at (b) birch 0.002 in., aspen 1.030 in.

Kirby, C. L. 1962. THE GROWTH AND YIELD OF WHITE SPRUCE-ASPEN STANDS IN SASKATCHEWAN. Tech. Bull. For. Br. Sask. No. 1, 58 pp. 48 refs.
Applies to Picea glauca/Populus tremuloides stands undisturbed by fire or felling, with emphasis on the growth and yield of P. glauca. Subjects covered include prediction of increment and deduction for cull. Shelterwood and strip felling of P. glauca appear to be promising ways of obtaining the desired regeneration of that species.

———— Bailey, W. S., and Gilmour, J. R. 1957. THE GROWTH AND YIELD OF ASPEN [POPULUS TREMULOIDES] IN SASKATCHEWAN. Tech. Bull. For. Br. Sask. No. 3, 67 pp. 14 refs.

Robinove. 1931. GROWTH RATE OF ASPENS IN MICHIGAN. Biol. Abstr. 5: 11800.

Tunstell, G. 1945. GROWTH OF ASPEN: PROJECT M.S.-45 Silv. Res. Note Dom. For. Serv. No. 77, 2 pp.

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Kozlowski, T. T., and Winget, C. H. 1962. SEASONAL GROWTH AND DEVELOPMENT OF ASPEN STEMS. For. Res. Note Wis. Coll. Agric. No. 87, 4 pp. 15 refs.

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Ghent, A. W. 1954. THE TREATMENT OF DECAYED WOOD FROM DEAD TREMBLING ASPEN TREES FOR GROWTH-RING ANALYSIS. For. Chron. 30(3): 280-3.

562.2

Hubbard, J. W. 1956. GROWTH AND MORTALITY IN A NORTHERN MINNESOTA FOREST. Minn. For. Note No. 50, 2 pp.
Data derived from remeasurement, after 5 years, of 558 permanent 1/5-acre plots are presented and analyzed. A separate growth tabulation was made for Populus tremuloides, which has an almost straight-line growth curve, and Abies balsamea, which grows slowly up to 6 in. d.b.h., then accelerates greatly until about 10 in. d.b.h., when the growth rate levels off.

566 YIELD TABLES AND THEIR CONSTRUCTION

Plonski, W. L. 1956. NORMAL YIELD TABLES FOR BLACK SPRUCE, JACK PINE, ASPEN AND WHITE BIRCH IN NORTHERN ONTARIO. Rep., Div. For. Mgmt. Ont. Dep. Lds. For. No. 24, 40 pp.

Zehngraff, P. 1948. YIELDS OF ASPEN IN UNMANAGED STANDS. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 300, 1 p.

567 STAND TABLES

[U.S.A.: Lake St. For. Exp. Sta.] 1931. ASPEN NORMAL STAND TABLES. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 71.

6 FOREST MANAGEMENT

61 FOREST MANAGEMENT: GENERAL, THEORY AND PRINCIPLES

Zasada, Z. A. 1950. ASPEN MANAGEMENT PROBLEMS OF THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. Sta. Misc. Rep. No. 10, 23 pp. 98 refs.
Review of literature.

Zehngraff, P. 1947. POSSIBILITIES OF MANAGING ASPEN. U. S. For. Serv. Lake St. Aspen Rep. No. 21, 23 pp. Bblg.

———— 1949. ASPEN AS A FOREST CROP IN THE LAKE STATES. J. For. 47(7): 555-65. 14 refs.

644.5/6

[U.S.A.: Timberman.] 1958. DEER AND PULP MILLS COMPETE. Timberman 59(8): 44-6.

651 74

Zasada, Z. A. 1952. DOES IT PAY TO THIN YOUNG ASPEN? J. For. 50(10): 747-8.
Analyzes costs and profits from thinning young stands of Populus tremuloides.

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Zasada, Z. A., and Zehngraff, P. J. 1948. LOGGING COSTS OF ASPEN (POPULUS TREMULOIDES). U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 304, 1 p.

71 MARKETING OF FOREST PRODUCTS: GENERAL

Zasada, Z. A. 1949. MARKETING OF ASPEN (POPULUS TREMULOIDES). U. S. For. Serv. Lake St. Aspen Rep. No. 20, 10 pp. 6 refs

72 PRICES

Chase, C. D. 1947. ASPEN AVAILABILITY AND SUPPLY. U. S. For Serv. Lake St. Aspen Rep. No. 2, 15 pp. Bblg.

8 FOREST PRODUCTS AND THEIR UTILIZATION

Eades, H. W. 1940. REPORT ON A SHIPMENT OF ASPEN LOGS MADE TO SOUTH AFRICA. For. Prod. Lab., Dom. For. Serv., Can. 4 pp.

Johnson, R. P. A., and others. 1930. ASPEN: AVAILABILITY, PROPERTIES AND UTILIZATION. Tech. Bull. Minn. Agr. Exp. Sta. No. 70: 72.

810 GENERAL INFORMATION ON WOOD

Anonymous. 1939. CANADIAN ASPEN. Wood Inform. Series Timb. Comm. Eastern Can. No. 48, 1 p.

Betts, H. S. 1943. AMERICAN WOODS: ASPEN. U. S. For. Serv. 9 pp. Bblg.

Zasada, Z. A. 1947. ASPEN PROPERTIES AND USES. U. S. For. Serv. Lake St. Aspen Rep. No. 1, 9 pp.

811.12

Ribi, E. 1953. ELECTRON MICROSCOPIC INVESTIGATIONS OF THE CELL WALL ORGANIZATION OF WOOD. Exp. Cell. Res., New York 5(1): 161-72. 24 refs.
Presents a series of electron micrographs of sections of wood of Ochroma lagopus and Populus tremuloides and comments on the organization of cellulose fibrils in the cell walls.

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Buijtenen, J. P. van. [1962.] SAMPLING FIBER LENGTHS IN QUAKING ASPEN. Proc., 5th World For. Congr., Seattle 1960, Vol. 3 (Sect. 6B): 1367-9. 5 refs. [E.f.span.]
A study on 10-mm. increment cores at Wisconsin and Michigan. Fibre length increased with the logarithm of age from the pith; it was not related to direction, but fluctuated at random. The correlation coefficient of fibre measurements from pulped b.h. cores and from whole-tree pulps of 25 trees was 0.8.

Valentine, F. A. 1963. VARIATION IN FIBER LENGTH IN POPULUS TREMULOIDES CLONES. [Pap.] FAO World Consult. For. Genet., Stockh. 1963 No. FAO/FORGEN 63/-7/4. 8 pp. 6 refs.
Changes in fibre length were determined across the radius of the stem for five trees in each of four natural clones. The results indicate that fibre-length increases across the stem are more closely related to annual ring number than to distance of the sample from the pith.

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Hossfeld, R. L., and Kaufert, F. H. 1957. STRUCTURE AND COMPOSITION OF ASPEN BARK. For. Prod. J. 7(12): 437-9. 12 refs.
Discusses physical properties, morphology and anatomy, chemical composition [cf. Browning and Bublitz, 1953, P. tremuloides, 813.2], including the distribution of components in the tissue elements, pulping characteristics, and potential other uses. Pulping results are poor. At present fibres are only included in low-grade products where barking before pulping would not be economically justified.

812 PHYSICAL AND MECHANICAL PROPERTIES

Johnson, R. P. A. 1947. MECHANICAL PROPERTIES OF ASPEN (POPULUS TREMULOIDES). U. S. For. Serv. Lake St. Aspen Rep. No. 7, 16 pp.

812.31

Valentine, F. A. 1962. NATURAL VARIATION IN SPECIFIC GRAVITY IN POPULUS TREMULOIDES IN NORTHERN NEW YORK. Proc., 9th Ntheast. For. Tree Impr. Conf., Cyracuse 1961: 17-24. 3 refs.
Study of 200 randomly selected trees demonstrated that a relatively large variation in sp. gr. is present in the P. tremuloides population of this area.

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Clausen, V. H., and others. 1949. DEVELOPMENT OF COLLAPSE IN ASPEN LUMBER. Proc. U. S. For. Prod. Res. Soc. 3: 460-8. 7 refs.

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Davis, E. M. 1947. MACHINING AND RELATED PROPERTIES OF ASPEN (POPULUS TREMULOIDES). U. S. For. Serv. Lake St. Aspen Rep. No. 8, 8 pp.

813 WOOD CHEMISTRY

Pearl, I. A., and Beyer, D. L. 1960. STUDIES ON THE CHEMISTRY OF ASPENWOOD [POPULUS TREMULOIDES]. V. AN INVESTIGATION OF VARIOUS ASPEN SPENT LIQUORS AS SOURCES OF P-HYDROBENZOIC ACID AND OTHER COMPOUNDS. Tappi 43(6): 568-72. 8 refs. [Cf. Pearl and Beyer, 1959, P. tremuloides, 813.11.]

———— and Beyer, D. L. 1960. STUDIES ON THE CHEMISTRY OF ASPENWOOD. VI. PRODUCTS OF ALKALINE HYDROLYSIS OF VARIOUS PORTIONS OF THE ASPEN TREE. Tappi 43(7): 611-3. 8 refs.

———— and Beyer, D. L. 1963. STUDIES ON THE CHEMISTRY OF ASPENWOOD. XVI. FURTHER STUDIES ON THE ETHER EXTRACTIVES OF SPENT SULFITE LIQUOR FROM AUTHENTIC QUAKING ASPENWOOD [POPULUS TREMULOIDES]. Tappi 46(8): 502-5. 8 refs.
Reports on the isolation of substantial amounts of naringenin, and also of two other related materials with flavan and flavone structures. The occurrence of such compounds, never previously reported from aspenwood, may be of taxonomic importance.

———— Beyer, D. L., and Justman, O. 1962. STUDIES ON THE CHEMISTRY OF ASPENWOOD. XIV. THE ETHER-SOLUBLE PORTION OF SPENT SULFITE LIQUOR FROM AUTHENTIC QUAKING ASPENWOOD. Tappi 45(2): 107-13. 6 refs.

Ritter, G. J., and Hossfield, R. L. 1947. CHEMICAL UTILIZATION OF ASPEN. U. S. For. Serv. Lake St. Aspen Rep. No. 4, 19 pp. 12 refs.

Stanek, D. A. 1958. A STUDY OF THE LOW-MOLECULAR WEIGHT PHENOLS FORMED UPON THE HYDROLYSIS OF ASPENWOOD. Tappi 41(10): 601-9. 29 refs.
Seven crystalline aromatic compounds were isolated from the ether-soluble portion of the hydrolysis liquors obtained when extracts of Populus tremuloides were treated with water at 170° C. Evidence was obtained that these seven compounds might have been derived from P. tremuloides lignin.

Sultze, R. F. 1957. A STUDY OF THE DEVELOPING TISSUES OF ASPENWOOD. Tappi 40(12): 985-94. 34 refs.

813.1

Sergeeva, V. N., and Domburgs, G. 1959. A THERMOGRAPHIC INVESTIGATION OF THE THERMAL DECOMPOSITION OF LIGNOCELLULOSE Trud. Inst. Lesohoz. Probl., Riga No. 17: 83-92. [Russ.?] From abstr. in Chem. Abstr. 54(10): 10314-5. 1960.
Gives results of investigations made to ascertain the course o decomposition of cellulose from aspen lignocellulose as a functio of various factors, viz. type of thermal treatment, state of startin material (e.g., particle size), and the content of pentosans o other easily hydrolysable carbohydrates, under conditions ensur ing maximum glucosan yield.

Springer, E. L. 1961. RATE STUDIES OF THE HYDROTROPIC DELIG NIFICATION OF ASPEN WOOD [WITH ACIDIFIED SOLUTIONS OF TH HYDROTROPIC SALT NA XYLENESULPHONATE]. Abstr. of thesis, i Dissert. Abstr. 22(6): 1930. [Univ. Wis.]

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Baylis, P. E. T., and Pepper, J. M. 1958. THE ISOLATION OF LI NIN FROM ASPEN WOOD. Abstr. in Chemistry in Can., Ottawa 1 (4): 62.
A new type of lignin was isolated, by acidolysis of pre-extracte wood flour, and some of its chemical properties were studie The aspen lignin and that isolated previously from spruce by similar technique were compared.

Brink, D. L. 1954. THE COOKING PROCESS: XIII. THE EFFECT AQUEOUS SOLUTIONS OF PURE SODIUM HYDROSULFIDE ON THE CO STITUENTS OF [ASPEN] WOOD. Abstr. of thesis, in Dissert. Abs 14(6): 928-9. [Univ. Minn.]

The nature of the process and the substances obtained are discussed and it is suggested, from the character of the residual wood and the nature of the identifiable low molecular weight degradation products that aqueous solutions of pure NaHS are specific agents for the cleavage of protolignin linkages in aspen.

Buchanan, M. A., and others. 1949. NATIVE LIGNIN. II. NATIVE ASPEN LIGNIN. J. Amer. Chem. Soc. 71(4): 1297-9. 8 refs.

Busche, L. R. 1960. THE KLASON LIGNIN DETERMINATION AS APPLIED TO ASPENWOOD WITH SPECIAL REFERENCE TO ACID-SOLUBLE LIGNIN. Abstr. of thesis, in Dissert. Abstr. 21(1): 34. 1 ref. [Inst. Pap. Chem.]

Kavanagh, K. R., and Pepper, J. M. 1955. THE ALKALINE NITROBENZENE OXIDATION OF ASPEN WOOD AND LIGNIN MODEL SUBSTANCES. Canad. J. Chem. 33(1): 24-30. 15 refs.
Yields of vanillin and syringaldehyde from aspen wood and from model substances are compared and the results discussed with respect to the chemistry of aspen lignin.

Mugg, J. B. 1959. THE METHANOL-EXTRACTABLE MATERIALS IN NEWLY FORMED ASPENWOOD [POPULUS TREMULOIDES]. Tappi 42(4): 289-94. 25 refs.

Pearl, I. A. 1957. THE NATURE OF ASPEN LIGNIN. For. Prod. J. 7(2): 88-90. 1 ref.

———— and Beyer, D. L. 1957. NEW DEVELOPMENTS IN THE CHEMISTRY OF ASPEN LIGNIN. Tappi 40(1): 45-54. 7 refs.
The average OCH_3 content of Populus tremuloides lignin was found to be much less than the commonly accepted figure of 21%. Results of fractionation by means of isopropanol, ethyl ether, and ion-exclusion processes are presented.

———— and Beyer, D. L. 1959. STUDIES ON THE CHEMISTRY OF ASPEN WOOD. IV. OXIDATION OF ASPEN LIGNOSULPHATES WITH ALKALINE CUPRIC AND SILVER OXIDE. Tappi 42(9): 800-4. 17 refs.

———— and Beyer, D. L. 1962. STUDIES ON THE CHEMISTRY OF ASPENWOOD [POPULUS TREMULOIDES]. IX. P-HYDROXYBENZOIC ACID IN ASPEN KLASON LIGNIN. J. Organ. Chem. 27(6): 2287. 3 refs.

———— and Busche, L. R. 1960. STUDIES ON THE CHEMISTRY OF ASPENWOOD. XI. THE KLASON LIGNIN DETERMINATION AS APPLIED TO ASPENWOOD WITH SPECIAL REFERENCE TO ACID-SOLUBLE LIGNIN. Tappi 43(12): 961-70. 47 refs.

———— and Busche, L. R. 1960. STUDIES ON THE CHEMISTRY OF ASPENWOOD [POPULUS TREMULOIDES]. XII. STUDIES ON THE PREPARATION OF MILLED WOOD LIGNIN FROM QUAKING ASPENWOOD. Tappi 43(12): 970-4. 19 refs.
Describes the method of preparing milled wood lignin, using a bibratory ball mill specially constructed for sub-zero grinding temperatures, and presents the data obtained from fractions (isolated at −78° C.) examined on the basis of chemical analyses and ultraviolet and infra-red spectra. [From authors' summary].

———— Beyer, D. L., and Whitney, D. 1961. STUDIES ON THE CHEMISTRY OF ASPENWOOD. XV. FURTHER STUDIES ON THE OXIDATION OF ASPEN LIGNO-SULFONATES WITH ALKALINE CUPRIC AND SILVER OXIDES. Tappi 44(7): 479-84. 6 refs.

Pepper, J. M., and Hagerman, D. C. 1954. THE ISOLATION AND OXIDATION OF ASPEN LIGNINS. Canad. J. Chem. 32(5): 614-27. 17 refs.

———— and Siddiqueullah, M. 1961. THE EFFECT OF INITIAL ACID CONCENTRATION ON THE LIGNIN ISOLATED BY THE ACIDOLYSIS OF ASPEN WOOD. Canad. J. Chem. 39(7): 1454-61. 15 refs.
All lignin fractions isolated were studied for yield, methoxyl content, infrared absorption spectra, and the yields of vanillin and syringaldehyde obtained from them. Evidence is presented in support of the nonhomogeneity of the whole protolignin.

———— Baylis, P. E. T., and Adler, E. 1959. THE ISOLATION AND PROPERTIES OF LIGNIN OBTAINED BY THE ACIDOLYSIS OF SPRUCE AND ASPEN WOODS IN DIOXANE-WATER MEDIUM. Canad. J. Chem. 37(8): 1241-8. 15 refs. [Picea abies and Populus tremuloides.]

———— Brounstein, C. J., and Shearer, D. A. 1951. STUDIES ON LIGNIN BY MEANS OF CATALYTIC HYDROGENATION OF ASPEN WOOD AND WHEAT STRAW. J. Amer. Chem. Soc. 73(7): 3316-9. 10 refs.

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Jones, J. K. N., and Wise, L. E. 1952. THE HEMICELLULOSES PRESENT IN ASPEN WOOD (POPULUS TREMULOIDES). PART I. J. Chem. Soc., July, pp. 2750-6.

———— and Wise, L. E. 1952. THE HEMICELLULOSES PRESENT IN ASPEN WOOD (POPULUS TREMULOIDES). PART II. J. Chem. Soc., Sept., pp. 3389-93. 1 ref.

———— Merler, E., and Wise, L. E. 1957. THE HEMICELLULOSES PRESENT IN ASPEN WOOD (POPULUS TREMULOIDES). PART III. THE CONSTITUTION OF PENTOSAN AND HEXOSAN FRACTIONS. Canad. J. Chem. 35(7): 634-45. 14 refs.

Milks, J. E., and Purves, C. B. 1956. ATTEMPTED PREPARATION OF A HOMOGENEOUS HEMICELLULOSE FROM ASPEN WOOD. J. Amer. Chem. Soc. 78(15): 3738-44. 33 refs.

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Jones, J. K. N., Purves, C. B., and Timell, T. E. 1961. CONSTITUTION OF A 4-O-METHYLGLUCURONOXYLAN FROM THE WOOD OF TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.). Canad. J. Chem. 39(5): 1059-66. 42 refs.
The studies showed that the polysaccharide is similar to the 4-0-methylglucuronoxylans occurring in the wood of all arborescent angiosperms so far investigated.

813.2

Abramovitch, R. A., and Micetich, R. G. 1962. EXTRACTIVES FROM POPULUS TREMULOIDES HEARTWOOD: THE STRUCTURE AND SYNTHESIS OF TREMULONE. Canad. J. Chem. 40(10): 2017-22. 18 refs.

———— and Micetich, R. G. 1963. EXTRACTIVES FROM POPULUS TREMULOIDES HEARTWOOD: THE TRITERPENE ALCOHOLS. Canad. J. Chem. 41(9): 2362-7. 25 refs.

———— Micetich, R. G., and Smith, S. J. 1963. EXTRACTIVES FROM POPULUS TREMULOIDES (ASPEN POPLAR) HEARTWOOD. Tappi 46(1): 37-40. 14 refs.
Reports the isolation and characterization of a number of free fatty acids, β-sitosterol glucoside, a number of normal aliphatic hydrocarbons, three normal aliphatic alcohols, a crystalline ketone, various sterols, unsaturated alcohols, keto alcohols, and a steam-volatile fraction. Contrary to a previous report [see Pearl and Harrocks, 1961, this subject classification], β-sitosterol was present in the nonsaponifiable fraction.

Browning, B. L., and Bublitz, L. O. 1953. EXTRACTIVES OF ASPENWOOD AND BARK. Tappi 36(9): 418-9. 6 refs.
The ether-soluble portion of extractives is characterized by a high content of fatty acids and contributes to the formation of hardwood pitch. Seasoning decreases the ether-soluble material in both wood and bark.

Clermont, L. P. 1961. THE FATTY ACIDS OF ASPEN POPLAR, BASSWOOD, YELLOW BIRCH AND WHITE BIRCH. Pulp Paper Mag. Can. 62(12): T511-T514. 8 refs.
Whenever possible, each species was separated into sapwood and heartwood, and each portion extracted with ether. The extracts were fractionated into (a) free fatty acids, (b) combined fatty acids, and (c) unsaponifiable material. Results are tabulated in detail.

Harrocks, J. A. 1960. AN INVESTIGATION OF THE NEUTRAL MATERIALS IN THE BENZENE EXTRACT OF ASPENWOOD. Abstr. of thesis, in Dissert. Abstr. 21(1): 53. 1 ref. [Inst. Pap. Chem.]
The relatively large amounts of extractives of resins in the wood, not easily removed during pulping or bleaching, may later cause such problems as pitch or loss of absorbency. Little is known of the nature of these resins, and this thesis investigates the neutral portion of the benzene extract of Populus tremuloides.

Pearl, I. A., and Harrocks, J. A. 1961. STUDIES ON THE CHEMISTRY OF ASPENWOOD. X. NEUTRAL MATERIALS FROM THE BENZENE EXTRACTIVES OF POPULUS TREMULOIDES. J. Organ. Chem. 26(5): 1578-83. 18 refs. [Cf. Pearl and Busche, 1960 (two refs.), 813.11.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Wilde, S. A., and Paul, B. H. 1959. GROWTH, SPECIFIC GRAVITY, AND CHEMICAL COMPOSITION OF QUAKING ASPEN ON DIFFERENT SOIL TYPES. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 2144, 4 pp. 6 refs.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Fernow. 1917. THE USES OF ASPEN POPLAR. Canad. For. Mag. 13: 1185-6.

831.51

Gunderson, W. R. H. 1949. HOME-TREATED FENCE POSTS SERVE WELL. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 325, 1 p.

832.1

Telford, C. J., and Malcolm, F. B. 1947. MILLING OF ASPEN INTO LUMBER. U. S. For. Serv. Lake St. Aspen Rep. No. 4, 9 pp.

832.15

Wallin, W. B. 1958. THE INFLUENCE AND IMPORTANCE OF DEFECTS AND LOG GRADES ON LUMBER GRADE YIELD FROM ASPEN LOGS. Abstr. of thesis, in Dissert. Abstr. 18(4): 1193. [Univ. Minn.]

832.18

Sands, W. 1947. ASPEN (POPULUS TREMULOIDES) FOR CONTAINERS. U. S. For. Serv. Lake St. Aspen Rep. No. 10, 12 pp. Bblg.

832.2

Feihl, A. O. 1958. VENEER AND PLYWOOD FROM ASPEN POPLAR. Canad. Woodworker, Toronto, Jan. 3 pp.

Garland, H. 1948. ASPEN FOR VENEER. U. S. For. Serv. Lake St. Aspen Rep. No. 13, 10 pp. 14 refs.

Miller, D. G. 1952. A PRELIMINARY INVESTIGATION OF VENEER CUTTING PROPERTIES OF ASPEN POPLAR. Mimeo. For. Prod. Lab., Can. No. 0-167, 9 pp.
In tests on a small shipment of logs of P. tremuloides, optimum lathe settings (knife angle 90° 30′ and 90° 0′, horizontal opening of pressure bar 0.058 and 0.115 in. and horizontal opening 0.016 and 0.032 in. for 1/16-in. and 1/8-in. respectively) were determined. In tests on eight representative bolts, yields of 70% of the log volume were obtained, 49% grade 1, 21% grade 2, and 30% grade 3. The veneers dried and glued satisfactorily.

———— 1953. VENEER CUTTING PROPERTIES OF CANADIAN ASPEN: A PRELIMINARY INVESTIGATION. Wood 18(7; 8): 253-5; 299-301.

Toole, A. W. 1947. ASPEN FOR CORE STOCK. U. S. For. Serv. Lake St. Aspen Rep. No. 11, 9 pp.

833 TIMBER IN BUILDINGS AND ENGINEERING STRUCTURES (MANUFACTURE AND USE)

Rees, L. W. 1947. ASPEN [POPULUS TREMULOIDES] LUMBER FOR BUILDING PURPOSES. U. S. For. Serv. Lake St. Aspen Rep. No. 9, 11 pp. 13 refs.

Sump, A. W. 1947. ASPEN FOR CABIN LOGS. U. S. For. Serv. Lake St. Aspen Rep. No. 15, 12 pp. Bblg.

834.9

Heebink, T. B. 1962. PERFORMANCE OF PALLETS FROM LOW-QUALITY ASPEN. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 2264, 7 pp. 7 refs.
Describes tests, in which aspen pallets were revolved in drums and dropped on their corners, the results of which were compared with those for pallets of other hardwoods. Toughness values are given for aspen in green and dry condition.

835 INDUSTRIAL AND DOMESTIC WOODWARE (MANUFACTURE AND USE)

Panshin, A. J. 1950. DIMENSION STOCK AND OTHER USES OF ASPEN [POPULUS TREMULOIDES]. U. S. For. Serv. Lake St. Aspen Rep. No. 12, 18 pp. 13 refs.

839.1

Garland, H. 1949. ASPEN FOR EXCELSIOR. U. S. For. Serv. Lake St. Aspen Rep. No. 16, 10 pp. 14 refs.
Includes a brief history of the wood-wool industry, and discusses the suitability of Populus tremuloides for this purpose.

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Kaufert, F. H. 1948. THE PRESERVATIVE TREATMENT OF ASPEN. U. S. For. Serv. Lake St. Aspen Rep. No. 19, 19 pp. 8 refs.

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Trenk, F. B. 1955. INDICATIONS OF SERVICEABILITY OF FENCE POSTS TREATED WITH WATER GAS TAR BY HOT AND COLD BATH PROCESS—SPOONER BRANCH EXPERIMENT STATION. For. Res. Note Wis. Coll. Agric. No. 24, 2 pp.
Reports a small-scale experiment with aspen, jack pine, and white cedar (Thuja occidentalis). A treating schedule is given. Absorption was good in all species, and after 8 years in service, 11 out of 13 aspen, and all the jack pine and white cedar posts were sound while all controls had rotted off.

847 DRYING (SEASONING)

Smith, H. S. 1947. SEASONING OF ASPEN [POPULUS TREMULOIDES]. U. S. For. Serv. Lake St. Aspen Rep. No. 5, 19 pp. 16 refs.

852.15

Hossfeld, R. L., Oberg, J. C., and French, D. W. 1957. THE APPEARANCE AND DECAY RESISTANCE OF DISCOLOURED ASPEN. For. Prod. J. 7(10): 378-82. 3 refs.
Observations in fence-post trials and soil-block decay tests indicate that discolored woods associated with knots, Nectria canker, and "wetwood" were more resistant to decay than ordinary sapwood. Alcohol extracts from fluorescent wood were more toxic towards test fungi than those from nonfluorescent wood.

Oberg, J. C., Hossfeld, R. L., and Kaufert, F. H. 1956. FLUORESCENT MATERIALS ASSOCIATED WITH DISCOLORATION IN ASPEN. Tappi 39(7): 470-1. 6 refs.
Extractives from discolored zones in the wood of Populus tremuloides have been shown by paper partition chromatography to include a well defined group of strongly fluorescent compounds. Their nature and composition appear to be independent of the nature of the associated types of injury (e.g. by Saperda calcarata).

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Clermont, L. P., and Bender, F. 1958. THE CHEMICAL COMPOSITION AND PULPING CHARACTERISTICS OF NORMAL AND TENSION WOOD OF ASPEN POPLAR AND WHITE ELM. Pulp Paper Mag. Can. 59(7): 139-43. 7 refs.

Terrell, B. Z. 1953. DISTRIBUTION OF TENSION WOOD AND ITS RELATION TO LONGITUDINAL SHRINKAGE IN ASPEN. Mater. Veg. 1(3): 288-99. 6 refs. [E.f.]

852.35

Kemp, A. K. 1957. STUDY OF FACTORS ASSOCIATED WITH THE DEVELOPMENT OF COLLAPSE DURING KILN DRYING OF ASPEN LUMBER. Abstr. of thesis, in Dissert. Abstr. 17(9): 1858-9. [Univ. Minn.]
Factors studied were temperature, humidity, sp. gr., water and air volume, rate of drying, and behavior of heartwood, sapwood, and wetwood.

———— 1959. FACTORS ASSOCIATED WITH THE DEVELOPMENT OF COLLAPSE IN ASPEN DURING KILN DRYING. For. Prod. J. 9(3): 124-30. 24 refs.

854 "GRADING" OF CONVERTED TIMBER

Anonymous. 1947. OFFICAL GRADING RULES FOR NORTHERN WHITE PINE (PINUS STROBUS), NORWAY PINE (PINUS RESINOSA), EASTERN SPRUCE (PICEA GLAUCA AND P. MARIANA), JACK PINE (PINUS BANKSIANA), BALSAM (ABIES BALSAMEA), ASPEN (POPULUS TREMULOIDES). Northern Hemlock and Hdwd. Mfrs. Ass., Oshkosh, Wis. 55 pp.
Conforming to American lumber standards.

———— 1949. STANDARD GRADING RULES FOR NORTHERN WHITE PINE, NORWAY PINE, JACK PINE, EASTERN SPRUCE, WESTERN WHITE SPRUCE, BALSAM, TAMARACK, ASPEN LUMBER. Northern Pine Mfrs. Ass., Minneapolis, Minn. 36 pp.

Zasada, Z. A. 1948. ASPEN [POPULUS TREMULOIDES] LUMBER GRADES AND CHARACTERISTICS. U. S. For. Serv. Lake St. Aspen Rep. No. 6, 9 pp.

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Brown, K. J., and McGovern, J. N. 1950. PRODUCTION OF HIGH-YIELD PULPS FROM ASPEN (POPULUS TREMULOIDES) BY MILD TREATMENTS WITH SODIUM HYDROXIDE. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. R1774, 6 pp. 3 refs.

Nihlen, H., and McGovern, J. N. 1943. SUITABILITY OF BIRCH, ASPEN AND SUGARBERRY FOR RAYON PULP: RESULTS OF CERTAIN SULFITE PULPING AND BLEACHING EXPERIMENTS. Mimeo. U. S. For. Serv. For. Prod. Lab., Madison No. R1441, 11 pp. Bblg.

Schafer, E. R. 1947. ASPEN FOR PULP AND PAPER. U. S. For. Serv. Lake St. Aspen Rep. No. 14, 10 pp. Bblg.

———— 1947. ASPEN FOR PULP AND PAPER. Pulp Paper Mag. Can. 48(13): 104, 106, 108-9. Bblg.

———— and Hyttinen, A. 1950. THE GROUNDWOOD PULPING OF MIXTURES OF WHITE SPRUCE AND QUAKING ASPEN. Tappi 33(7): 335-7.
As the amount of aspen in the mixture increased, the motor load remained constant but the grinding rate increased, energy consumption decreased, freeness increased, and strength decreased, the relationships being nearly linear.

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Atwell, E. A. 1956. DECAY AND DISCOLOURATIONS IN POPLAR PULPWOOD. F.P.L. Tech. Note For. Prod. Lab. Can. No. 1, 24 pp. 10 refs.

Buijtenen, J. P. van, Joranson, P. N., and Einspahr, D. W. 1958. DIPLOID VERSUS TRIPLOID ASPEN AS PULPWOOD SOURCES WITH REFERENCE TO GROWTH, CHEMICAL, PHYSICAL AND PULPING DIFFERENCES. Tappi 41(4): 170-5. 6 refs.

Hyttinen, A., Martin, J. S., and Keller, E. L. 1960. PULPING AND PAPERMAKING EXPERIMENTS ON QUAKING ASPEN FROM COLORADO. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. 2180, 5 pp.
Describes and discusses groundwood, sulphite, sulphate, and semi-mechanical pulping experiments made at Madison. Magazine coating-base papers made from the pulps showed that the sulphite pulp was stronger than that made from Lake States aspen, while the other pulps were almost as strong as the corresponding pulps made from Lake States aspen.

McGovern, J. N. 1946. USE OF BLEACHED ASPEN SEMICHEMICAL PULP IN GROUNDWOOD BOOK PAPER. Paper Tr. J. 123(20): 47-52. Bblg.

———— and Mackin, G. E. 1950. FARM WOODLOT ASPEN FOR CREPED TISSUE PAPER. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. R1783, 6 pp.

Mackin, G. E. 1948. BOOK PAPER FROM ASPEN SEMICHEMICAL AND GROUNDWOOD PULP. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. R1709, 3 pp. 2 refs.

861 X 13

Brown, K. J., and McGovern, J. N. 1950. PRODUCTION OF HIGH-YIELD PULPS FROM ASPEN BY MILD TREATMENTS WITH SODIUM HYDROXIDE. Tappi 33(8): 364-8. 3 refs.

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Montano, J., and Hossfeld, R. 1951. THE REACTION OF WOOD WITH ALKALINE SOLUTIONS OF SODIUM HYDROSULPHITE. Tappi 34 (10): 468-70. 20 refs.

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McGovern, J. N., and others. 1949. EXPERIMENTS ON WATER AND STEAM COOKING OF ASPEN. Tappi 32(10): 440-8. 12 refs.

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Atack, D., and May, W. D. 1962. MECHANICAL PULPING STUDIES WITH A MODEL STEEL WHEEL. Pulp Paper Mag. Can. 63(1): T10-T20. 12 refs.
A study using a specially designed apparatus, of the frictional resistance to sliding of rigid cylinders over Picea mariana, Abies balsamea, and Populus tremuloides wood in the presence of water and through a range of specific loading conditions embracing those employed in commercial grinding.

Hyttinen, A., Mackin, G. E., and Schafer, E. R. 1947. EXPERIMENTS ON THE GRINDING OF QUAKING ASPEN AND USE OF PULP IN PRINTING PAPER. Paper Tr. J. 125(13): 53-62. Bblg.

———— and Schafer, E. R. 1948. EFFECT OF DECAY ON THE GROUNDWOOD PULPING OF QUAKING ASPEN. Paper Indus. Paper World, June. 3 pp. 3 refs.

Schafer, E. R., and Hyttinen, A. 1950. EFFECT OF THE MOISTURE CONTENT OF WOOD ON THE GROUNDWOOD PULPING OF WHITE SPRUCE AND QUAKING ASPEN. Paper Tr. J. 131(5): 26-9.

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Diehm, R. A., Larson, H. L., and Meinstein, S. 1960. THE USE OF SURFACTANT IN THE COLD CAUSTIC PULPING OF ASPENWOOD. Tappi 43(4): 364-9. 2 refs.
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Discusses the results of pulping aspen and mixed hardwoods by the neutral sulphite semichemical method.

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Tabulates the effects of various cooking factors on the characters of the paper, describes a commercial operation and compares 100% aspen with spruce/aspen groundwood pulp, concluding that the former (45% being treated with NaOH) is equal in quality to the mixed pulp. Other tests compare aspen from four localities and the effect of varying wood moisture.

Lea, D. C. 1954. AN ORIENTING STUDY OF THE EFFECT OF THE NEUTRAL SULPHITE SEMICHEMICAL COOK ON THE HEMICELLULOSES OF ASPENWOOD. Tappi 37(9): 393-9. 29 refs.

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Trivedi, S. A., and others. 1948. EXTRACTION TREATMENTS IN BLEACHING ASPEN NEUTRAL SULPHITE SEMI-CHEMICAL PULP. Pap. Indus. 29: 1443-53. 23 refs.

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Stone, J. E., and Forderreuther, C. 1956. STUDIES OF PENETRATION AND DIFFUSION INTO WOOD. Tappi 39(10): 679-83. 2 refs.

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Hossfeld, R. L., Gortner, R. A., and Kaufert, F. H. 1943. THE COOKING PROCESS. ACTION OF AQUEOUS SOLUTIONS OF PURE SODIUM HYDROSULFIDE ON ASPEN WOOD. Industr. Engng. Chem. (Industr. Ed.) 35(6): 717-20. Bblg.

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Legg, G. W., and Hart, J. S. 1960. ALKALINE PULPING OF POPLAR AND BIRCH. THE INFLUENCE OF SULFIDITY AND EFFECTIVE ALKALI ON THE RATE OF PULPING AND PULP PROPERTIES. Tappi 43(5): 471-84. 24 refs.

Quick, R. H. 1956. A STUDY OF THE HEMICELLULOSE REMOVED DURING A NEUTRAL SULPHITE SEMICHEMICAL COOK OF ASPENWOOD. Tappi 39(6): 357-66. 23 refs.

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Keller, E. L., and McGovern, J. N. 1949. NEUTRAL SULPHITE SEMICHEMICAL PULPING OF ASPEN: EFFECT OF CERTAIN BUFFERING AGENTS. Tappi 32(9): 400-5. 10 refs.

Stone, J. E. 1955. A STUDY OF THE LIGNIN REMOVED DURING A NEUTRAL SULPHITE COOK OF ASPEN. Tappi 38(10): 610-2. 6 refs.

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Craig, R. 1948. ASPEN DEFIBERIZATION AND REFINING OF PRODUCT. U. S. For. Serv. Lake St. Aspen Rep. No. 17, 4 pp.
Brief account of Allis Chalmers, Asplund and other defibrators.

McGovern, J. N., and others. 1949. EXPERIMENTS ON WATER AND STEAM COOKING OF ASPEN. Tappi 32(10): 440-8. 12 refs.

March, R. E. 1948. THE EFFECT ON PULP QUALITY OF THE STEPWISE REMOVAL AND REPLACEMENT OF THE HEMICELLULOSES FROM ASPEN HOLOCELLULOSE. Paper Tr. J. 127(17): 51-7. 28 refs.

Springer, E. L., Harris, J. F., and Neill, W. K. 1963. RATE STUDIES OF THE HYDROTROPIC DELIGNIFICATION OF ASPENWOOD. Tappi 46(9): 551-5. 34 refs.
Covers work to date on an F.P.R.L., Madison, project designed to develop economic methods of separating and solubilizing the major wood components (lignin, hemicellulose, and cellulose), and includes descriptions of the experimental techniques developed and some rate-yield data for the Na m-xylene-sulphonate-sulphuric acid-water system acting on Populus tremuloides. Results are reported on a few degree-of-polymerization measurements made on residues of low lignin content.

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Kingsbury, R. M., Simmonds, F. A., Mills, R. T., and Fennell, F. L. 1946. BLEACHING ASPEN NEUTRAL SULPHITE SEMICHEMICAL PULP WITH SODIUM PEROXIDE. Paper Tr. J. 123(11): 50-4. Bblg.

Trivedi, S. A., and others. 1948. EXTRACTION TREATMENTS IN BLEACHING ASPEN NEUTRAL SULPHITE SEMI-CHEMICAL PULP. Pap. Indus. 29: 1443-53. 23 refs.

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Simmonds, F. A., Kingsbury, R. M., Martin, J. S., and Keller, E. L. 1953. PURIFIED HARDWOOD PULPS FOR CHEMICAL CONVERSION. I. ASPEN SULPHITE AND PREHYDROLYSIS-SULPHATE PULPS. Tappi 36 (3): 103-10. 18 refs.

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Anderson, E. A., and Hrubesky, C. E. 1949. UTILIZATION OF FARM WOODLOT WOODS FOR ROOFING FELT. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. R1739, 10 pp.

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Stranks, D. W. 1961. UTILIZATION OF ASPEN WOOD RESIDUES. For. Prod. J. 11(7): 288-92. 16 refs.

864 UTILIZATION OF LIGNIN

Buchanan, M. A., Lollar, R. M., and Niemeyer, D. D. 1947. THE TANNING PROPERTIES OF LIGNOSULPHENATES PRODUCED BY DIFFERENT COOKING CONDITIONS. Paper Tr. J. 124(18): 38-44. Bblg.

866 UTILIZATION OF WOOD EXTRACTIVES

Ritter, G. J., and Hossfield, R. L. 1947. CHEMICAL UTILIZATION OF ASPEN. U. S. For. Serv. Lake St. Aspen Rep. No. 4, 19 pp. 12 refs.

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Keller, E. L. 1950. EFFECT OF BARK IN THE NEUTRAL SULPHITE SEMICHEMICAL PULPING OF ASPEN, HICKORY, AND SLASH PINE. Tappi 33(11): 556-60. 12 refs.
Gives pulp yields from the three barks, the Na_2SO_3 consumption, the former being less and the latter greater than for wood fibre. In mixed bark and wood pulping, as the proportion of bark increased, the strength and density of standard test sheets decreased, aspen pulps being most and hickory least sensitive to the addition of bark.

892.49

Faber, H. B., Jr. 1960. THE METHANOL-EXTRACTABLE AROMATIC MATERIALS IN THE INNER BARK OF [POPULUS] TREMULOIDES. Tappi 43(5): 406-13. 40 refs.
Ten aromatic compounds were identified in the methanol extracts of aspen inner phloem and stone cell layers, and data on the seasonal variation of such substances as salicin, populin, tremuloidin, and ferulic acid in the various extracts, were obtained.

Hossfeld, R. L., and Hunter, W. T. 1958. THE PETROLEUM ETHER EXTRACTIVES OF ASPEN [POPULUS TREMULOIDES] BARK. Tappi 41 (7): 359-62. 21 refs.

Pearl, I. A., and Darling, S. F. 1959. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. I. TREMULOIDIN, A NEW GLUCOSIDE FROM THE BARK OF POPULUS TREMULOIDES. J. Organ. Chem. 24(6): 731-5. 21 refs.

———— and Darling, S. F. 1959. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. II. SALIREPOSIDE FROM THE BARK OF POPULUS TREMULOIDES. J. Organ. Chem. 24(10): 1616. 7 refs.
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9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

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[U.S.A.: Lake St. For. Exp. Sta.] 1931. FUTURE OF ASPEN IN THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. Sta. Tech. Notes No. 50.

905 FOREST STATISTICS AND RESOURCES

Zasada, Z. A., and Kluender, W. A. 1946. THE FUTURE OF ASPEN IN THE LAKE STATES. U. S. For. Serv. Lake St. For. Exp. St. Econ. Note No. 21, 11 pp. Bblg.

P. TRICHOCARPA TO P. YUNNANENSIS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

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Zelawski, W., and Fuchs, S. 1961. VERLAUF DER ATMUNGSANDERUNGEN IM HOLZ NACH DEM SCHNITT PARALLELUNTERSUCHUNGEN MIT DEM CO_2- UND WASSERDAMPF - URAS. [THE COURSE OF RESPIRATION IN WOOD AFTER SEVERING-PARALLEL STUDIES WITH CO_2 AND WATER-VAPOR INFRA-RED ABSORPTION RECORDERS.] Arch. Forstw. 10 (11/12): 1260-8. 17 refs. [G.g.russ.e.]

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Critchfield, W. B. 1959. LEAF DIMORPHISM IN POPULUS TRICHOCARPA. From abstr. in Proc., 9th Int. Bot. Congr., Montreal, vol. 2, p. 82.

———— 1960. LEAF DIMORPHISM ON POPULUS TRICHOCARPA. Amer. J. Bot. 47(8): 699-711. 39 refs.

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Gabriel, W. J. 1956. PRELIMINARY REPORT ON CLONAL DIFFERENCES IN THE WOOD AND PHLOEM OF POPULUS DELTOIDES AND P. TRICHOCARPA. Proc., 3rd Ntheast. For. Tree Impr. Conf., Ithaca 1955: 33-4.
Data from individual trees indicated statistically significant differences in fibre length and sp. gr. between clones of the two species studied. Variation were also apparent in the fibre arrangement in the phloem. The material was from trees 5 years of age or younger. Studies should be made on more mature trees to determine whether these juvenile traits are permanent or temporary.

165.53

Pauley, S. S. 1954. VARIATION IN TIME OF BREAK OF DORMANCY AMONG ALTIDUDINAL ACOTYPES OF POPULUS TRICHOCARPA. Abstr. in Genetics, Madison 39: 986-7.
Whereas short-growing-season ecotypes from high latitudes are characterized by precocity, short-growing-season ecotypes from high altitudes, when grown under uniform temperature and day-length conditions, proved significantly less precocious than low elevation, long-growing-season ecotypes. [Cf. Pauley, 1954, P. trichocarpa to P. yunnanensis, 181.21.]

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[New Zealand: Soil Conserv. Rivers Control Coun.] 1959. POPLAR INVESTIGATIONS. Extr. from Report, Soil Conserv. and Rivers Control Council, Wellington 1958/1959: 26-9.

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181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Roe, A. L. 1958. SILVICS OF BLACK COTTONWOOD [POPULUS TRICHOCARPA]. U. S. For. Serv. Intermt. For. Range Exp. Sta. Misc. Publ. No. 17, 18 pp. 23 refs.

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Pauley, S. S. 1954. THE PHOTOPERIODIC RESPONSE AND ITS IMPORTANCE IN TREE IMPROVEMENT. [Pap.] 8th Int. Bot. Congr., Paris, Sect. 13: 13-6.

Sebald, O. 1958. UBER DIE LICHTANSPRUCHE DER PAPPELSORTEN. [LIGHT REQUIREMENTS OF POPLAR VARIETIES.] Holzzucht, Reinbek 12(2): 13. 2 refs. [G.]
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2 SILVICULTURE

Harris, K. F. 1950. GROWING GOOD QUALITY SECOND-GROWTH ALDER. B. C. Lumberman 34(7): 41, 109-10, 112.

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Bloomberg, W. J. 1959. ROOT FORMATION OF BLACK COTTONWOOD [POPULUS TRICHOCARPA] CUTTINGS IN RELATION TO REGION OF PARENT SHOOT. For. Chron. 35(1): 13-7. 1 ref.

Larsen, C. M. 1948. EXPERIMENTS WITH SOFTWOOD CUTTINGS OF HENRY'S POPLAR. Aarsskr. Vet.-Landbohojsk 1948: 42-63. 20 refs. [E.e.]

4 FOREST INJURIES AND PROTECTION

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Thomas, G. P., and Podmore, D. G. 1953. STUDIES IN FOREST PATHOLOGY. XI. DECAY IN BLACK COTTONWOOD IN THE MIDDLE FRASER REGION, BRITISH COLUMBIA. Canad. J. Bot. 31(5): 675-92. 13 refs. (Contr. Div. For. Biol. Dep. Agric. Can. No. 57.)

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Bier, J. E. 1959. THE RELATION OF BARK MOISTURE TO THE DEVELOPMENT OF CANKER DISEASES CAUSED BY NATIVE FACULTATIVE PARASITES. II. FUSARIUM CANKER ON BLACK COTTONWOOD. Canad. J. Bot. 37: 781-8.

———— 1962. ACTI-DIONE AND NATURAL BARK EXTRACTS IN THE CONTROL OF HYPOXYLON CANKER OF POPLAR. For. Chron. 38 (3): 363-5. 4 refs.

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Heilgendorff. 1931. GAME DAMAGE TO P. TRICHOCARPA. Mitt. Dtsch. Dendrol. Ges. 43: 353.

5 FOREST MENSURATION

542 BY ECOLOGICAL METHODS

Smith, J. H. G. 1957. SOME FACTORS INDICATIVE OF SITE QUALITY FOR BLACK COTTONWOOD (POPULUS TRICHOCARPA TORR. AND GRAY). J. For. 55(8): 578-80. 4 refs.
Climatic influence, topography and soil requirements are discussed in relation to growth of P. trichocarpa in British Columbia, and vegetation indicative of site classes, I, II, and III is listed.

8 FOREST PRODUCTS AND THEIR UTILIZATION

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Brown, C. L., and Sax, K. 1962. THE INFLUENCE OF PRESSURE ON THE DIFFERENTIATION OF SECONDARY TISSUES. Amer. J. Bot. 49(7): 683-91. 8 refs.

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Kennedy, R. W. 1957. FIBRE LENGTH OF FAST- AND SLOW-GROWN BLACK COTTONWOOD [POPULUS TRICHOCARPA]. For. Chron. 33(1): 46-50. 11 refs.
The lengths of fibres from fast- and slow-grown trees were measured at comparable height and ages. Fibre length was found to vary directly and significantly with both growth rate and age from pith. An additional investigation showed that fast-grown stool-shoots had longer fibres than slow-grown ones from the same stump. The mechanisms regulating fibre length in trees are discussed briefly. [From author's summary.]

812 PHYSICAL AND MECHANICAL PROPERTIES

[U.S.A.: U. S. For. Prod. Lab.] 1950. VENEER CUTTING AND DRYING PROPERTIES. COTTONWOOD. Rep. U. S. For. Serv. For. Prod. Lab., Madison No. D1766-3, 4 pp. 4 refs.

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Mozeiko, L., and Sergejeva, V. 1958. [CHANGES IN THE NATURE OF THE LIGNIN IN WOOD OF FAST-GROWING POPLAR UNDER THE INFLUENCE OF GROWTH CONDITIONS.] Latvijas PSR Zinatnu Akademijas Vestis, Riga 1958(4): 57-69. [Russ.]
From abstr. in Holzforschung, Berlin 13(5): 157. 1959. [G.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Cech, M. Y., Kennedy, R. W., and Smith, J. H. G. 1960. VARIATION IN SOME WOOD QUALITY ATTRIBUTES OF ONE-YEAR-OLD BLACK COTTONWOOD [POPULUS TRICHOCARPA]. Tappi 43(10): 857-9. 12 refs.

831.6

Mueller, L. A. 1948. COTTONWOOD RAILWAY TIE TEST COMPLETED. U. S. For. Serv. Nth. Rocky Mt. For. Range Exp. Sta. Res. Note No. 67, 2 pp.

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Anonymous. 1927. BRITISH COLUMBIA COTTONWOOD FOR MATCHES. Canad. For. Mag. 23: 208.

841 WOOD PRESERVATION

Cheng, C. S. 1949. THE SOAKING TREATMENT OF BLACK COTTONWOOD AND RED ALDER FENCE POSTS IN PENTACHLOROPHENOL. J. For. 47(8): 651-2.

U. S. FOREST SERVICE RESEARCH PAPER SO-28 1967

Forest Genetics Publications by the Southeastern and Southern Forest Experiment Stations, 1962 Through 1966

John C. Barber

and

Keith W. Dorman

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Forest Genetics Publications by the Southeastern and Southern Forest Experiment Stations, 1962 Through 1966

John C. Barber
Southern Forest Experiment Station

Keith W. Dorman
Southeastern Forest Experiment Station

The forest genetics and tree improvement programs of the Southeastern and Southern Forest Experiment Stations are closely coordinated and supplement or support each other at many points.

A joint listing of the two Stations' genetics publications through 1961 is available in Occasional Paper 192 of the Southern Forest Experiment Station. Since that year more than 200 additional publications have resulted from this research. They are listed here, to provide a unified supplement to Occasional Paper 192 from 1962 through 1966.

Most of the recent, and numbers of the earlier, releases and reprints are still available. Those marked SE may be requested from the Southeastern Forest Experiment Station, P. O. Box 2570, Asheville, North Carolina 28802; and those marked SO from the Southern Forest Experiment Station, T-10210 Federal Building, 701 Loyola Avenue, New Orleans, Louisiana 70113.

This list is alphabetical by senior authors. An index of junior authors appears on page 23.

Allen, R. M.

1964. Contributions of roots, stems, and leaves to height growth of longleaf pine. Forest Sci. 10: 14-16. SO

Saplings made 31 percent of their normal spring elongation from food reserves in the stem. Roots supplied materials for an additional 15 percent, and old leaves for an apparent 40 percent.

——— and McGregor, W. H. D.

1962. Seedling growth of three southern pine species under long and short days. Silvae Genet. 11: 43-45. SO

Loblolly pine from southerly seed sources made more height growth under long or short days than seedlings from more northern sources; growth patterns revealed the interaction of a photoperiodic control process and a seasonal rhythmic process. Shortleaf grown under short days exhibited a clinal pattern like that of loblolly, but under long days showed differences more suggestive of ecotypes. Longleaf grew larger under long days than under short, but showed no differences attributable to geographic source.

Asher, W. C.

1964. A formula for estimating slash pine seed yields. J. Forest. 62: 37-39. SE

Estimates of sound seed yields per bushel of cones are necessary in planning seed collection programs. Seed yield of slash pine can be estimated by means of the regression equation, $Y = 12.7 + 9.31X$, where Y = estimated sound seed per cone and X = number of sound seeds exposed by slicing the cone longitudinally in half. This formula has wide applicability in Georgia and Florida. The correlation coefficient, r, is 0.85 and is highly significant. In application, about five cones each from 25 to 30 trees are halved longitudinally and the number of sound seed exposed entered as X in the equation. Estimated sound seed yield in pounds per bushel of cones are tabulated for large, medium, and small seeds and several different cone sizes.

Asher, W. C.

1964. Electrical potentials related to reproduction and vigor in slash pine. Forest Sci. 10: 116-121. SE

Electrophysiological techniques show promise as valuable research tools in tree physiology. Electrical potential measurements on slash pine branch material give significant correlations with presence or absence of female flower buds and with geographic distribution of this species. Studies on slash pine flower scales showed that the electrical potential of the nucellus with respect to the dorsal surface of the ovule reversed polarity upon pollination.

Barber, J. C.

1962. Tree seed certification programs and needs of Georgia. Annu. Meeting Western Reforestation Comm. Proc. 1961: 7-10. SE

A description of the program and benefits expected.

1963. How much is forest genetics helping the forester by increasing growth, form, and yield? Seventh Southern Forest Tree Impr. Conf. Proc. 1963: 16-20. SE

Heritability estimates for high growth, form, and yield of wood are summarized for southern pines.

1964. Inherent variation among slash pine progenies at the Ida Cason Callaway Foundation. U. S. Forest Serv. Res. Pap. SE-10, 90 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Two open-pollinated slash pine progeny tests were examined at ages up to 9 years from seed. Data analyzed included height, d.b.h., pruning height, stem straightness, forking, fusiform rust infection, and survival. Branching characteristics and bark thickness were also examined. Differences among progenies were tested and correlation values determined between many traits. Narrow-sense heritability values were calculated for height (0.03-0.37), d.b.h. (−0.22-0.37), pruning height (0.36-0.64), and crown width (0.16-0.19). Silvicultural application of information was discussed, and the importance of proper progeny test design.

1965. Progeny-testing forest trees for seed certification purposes. Forty-Sixth Annu. Rep. Int. Crop. Impr. Assoc. 1964: 83-87. SO

Discusses general principles of establishing tests and indicates responsibilities of producer, buyer, and certifying agency.

1965. Seed. *In* A Guide to Loblolly and Slash Pine Plantation Management in Southeastern USA, pp. 3-9. Ga. Forest Res. Counc. Rep. 14, 360 pp. SE

Emphasizes the importance of collecting pine seed from the proper geophysical and altitudinal area and from genetically suitable trees. Correct handling, storage, and extraction procedures are necessary so that the seed will not be damaged.

1966. A report on progress in forest genetics. Forest Farmer 26(2): 12-13, 37-38. *Also as* A progress report on forest genetics. APA Quart., October 1966, pp. 4, 6. SO

General summary for the South.

1966. Genetics, seed orchards and forest farming. Forest Farmer 25(7): 104-105. SO

Genetics research has provided the forest farmer with means of improving his timber stands and his income from forestry.

1966. The use of automatic data processing in tree improvement and genetics program. Forest Sci. 12: 214-224. SE

The methods are designed for equipment available in most industries and large governmental offices.

1966. Variation among half-sib families from three loblolly pine stands in Georgia. Ga. Forest Res. Counc. Res. Pap. 37, 5 pp. SE

Initial survival and 5-year total heights and fusiform rust infection are reported for 11 half-sib families from each of three stands representing a NW-SE transect across Georgia. Significant differences were found between sources for the three characters. The southern source survived poorest; the northern source grew slowest; and the local source had lowest rust infection. Differences among families within sources were greater than differences between source means.

——— and Dorman, K. W.

1964. Clonal or seedling seed orchards? Silvae Genet. 13(1-2): 11-17. SE

Data are presented on oleoresin yield, wood specific gravity, and stem volume in full sibs of slash pine with correlations and the range of variation. Also, measurement data from a 7-year-old slash pine seedling seed orchard for form, height growth, and disease infection are given. These data, plus problems in length of time required for establishment and those in connection with

progeny testing for seed certification, are discussed from the standpoint of seed orchard establishment. It is concluded that the advantages claimed for seedling seed orchards over clonal orchards in some theoretical discussions cannot be realized when tree species are involved that are inherently variable in several economically important traits.

Barnes, R. L.

1963. Nitrogen metabolism in relation to flowering in pine. (Abstr.) Assoc. Southeast. Biol. Bull. 10(2): 23. SE

Nitrogen composition, metabolism, and translocation in relation to flowering and fruiting in loblolly pine.

1965. Relations between nitrogen content and flowering in pine. (Abstr.) Soc. Amer. Forest. Proc. 1964: 47. SE

Recent studies indicate that analyses of soluble nitrogen fractions in the woody twigs provide a better evaluation of the nitrogen status of pines than the previously used determinations of total foliar nitrogen content. A study in an intensively cultured "orchard" of slash pine in Florida is evaluating changes in nitrogen status of the trees as a result of nitrogen fertilization, as well as relating nitrogen responses and flowering. Differences in arginine and total amino acid content due to treatment are apparent, as are differences in arginine content of eight clones selected for differences in past flowering.

Barnett, J. P., and McLemore, B. F.

1965. Cone and seed characteristics of sand pine. U. S. Forest Serv. Res. Pap. SO-19, 13 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Trees of the Choctawhatchee race, from western Florida, averaged 1,010 cones per bushel and 56,100 seeds per pound. The Ocala race of peninsular Florida averaged 830 cones per bushel and 47,200 seeds per pound. Choctawhatchee cones open readily at 105° F.; Ocala cones will open if dipped in boiling water and then dried. Ocala cones 2 or more years old yield seed of decreased viability, but seed from both races is easily stored at 10 percent moisture and 25° F. Choctawhatchee seed requires stratification for 14 days, but Ocala seed from new and 1-year cones is nondormant.

——— and McLemore, B. F.

1966. Repellent-coated pine seed can be stored. Forest Farmer 25(9): 14. SO

The seed can be stored at least 1 year, even after stratification.

——— and McLemore, B. F.

1966. Sand pine cones and seed. U. S. Forest Serv. Tree Planters' Notes 76, pp. 15-16. SO

See second entry above.

Barrett, J. P.

1963. Slash pine gum flow unaffected by seed origin. Forests and People 13(2): 18-19. *Also in* Nav. Stores Rev. 73(7): 4-5. SO

In a plantation near Alexandria, Louisiana, no differences in gum yield were found among trees representing seven seed sources in the lower Coastal Plain.

——— and Bengtson, G. W.

1964. Oleoresin yields for slash pines from seven seed sources. Forest Sci. 10: 159-164. SO-SE

Evaluations of the oleoresin-yielding potential of Pinus elliottii *var.* elliottii *from a number of geographic sources planted in Louisiana 200 miles west of natural range of the species. Seed sources ranging from South Carolina to Florida and westward to Louisiana did not differ in oleoresin yield under microchipping, nor in viscosity and exudation pressure of the resin. Individual trees, by contrast, varied greatly—their productivity being correlated with diameter, length of live crown, ratio of crown length to total height of tree and viscosity of resin.*

Bengtson, G. W.

1963. Slash pine selected from nurserybeds: 8-year performance record. J. Forest. 61: 422-425. SE

After 8 years in the field under fairly typical "flatwoods" plantation conditions, outstanding slash pine seedlings selected from nurserybeds showed a mean height superiority of 23 percent over average stock.

1965. Progress, problems, and plans in physiological research conducted in an intensively cultured orchard of slash pine. (Abstr.) Soc. Amer. Forest. Proc. 1964: 47. SE

An intensively cultured slash pine orchard of 24 clones of known oleoresin-yielding potential has been subjected to fertilization, irrigation, and ground cover manipulation since 1959. In terms of height and diameter growth, fertilizers have had no effect to date. Irrigation increased stem growth, but only when the ground cover was left undisturbed. The most significant results concern tree flowering in response to treatment.

Bennett, F. A.

1964. Growth, yield, and diameter distributions in slash pine plantations. (Abstr.) Assoc. Southern Agr. Workers Proc. 1964: 165-166. SE

Diameter distributions in slash pine plantations are shown to be highly correlated with mean diameter. This in turn reflects the strong effect of density, and increasing competition, on the shifting distributions. Diameter distributions are used to illustrate the effect of initial spacing on the first thinning and the residual stand.

1965. Diameter distributions in slash pine plantations. Soc. Amer. Forest. Proc. 1964: 234-237. SE

Several approaches are used to investigate diameter distributions in slash pine plantations. Distributions are established as a function of mean diameter. These data help in planning naval stores operations and thinning schedules.

Berry, C. R.

1964. Eastern white pine, a tool to detect air pollution. Southern Lumberman 209 (2609): 164, 166. SE

Clonal lines of eastern white pine are being developed for use as biological indicators of specific types of air pollutants. Use of these clones permits the detection of low levels of air pollution, determination of relative concentrations involved, and identification of specific pollutants.

——— and Hepting, G. H.

1964. Injury to eastern white pine by unidentified atmospheric constituents. Forest Sci. 10: 2-13. SE

A general decline of Pinus strobus *L. found in the Kingston-Oak Ridge area of Tennessee and in other industrial areas was caused by an atmospheric agent. Trees differed greatly in susceptibility to the disease, and grafts made on healthy trees with both resistant and healthy scion material remained in their original condition when left in the affected area. Sulfur dioxide and fluorine are regarded as possible causes of this injury.*

Bethune, J. E.

1963. Introduction of loblolly pine south of its natural range in Florida. J. Forest. 61: 782, 784. SE

After 6 years, survival and growth compare favorably with those of other planted and exotic pines.

1963. Pine tip moth damage to planted pines in south Florida. U. S. Forest Serv. Res. Note SE-7, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

South Florida slash pine is less susceptible to pine tip moth than either typical slash pine or loblolly pine.

1966. Performance of two slash pine varieties planted in south Florida. U. S. Forest Serv. Res. Pap. SE-24, 9 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Compares survival, growth, and other characteristics of planted South Florida slash pine (Pinus elliottii *var.* densa *Little & Dorman) and the typical slash pine variety* (Pinus elliottii *var.* elliottii *Engelm.) through age 9. South Florida slash pine is more resistant to most pests and to fire, and suffers relatively less growth loss following cattle damage. The typical variety survives better, grows faster during the first years after planting, and has more resistance to wind damage.*

——— and Langdon, O. G.

1966. Seed source, seed size, and seedling grade relationships in South Florida slash pine. J. Forest. 64: 120-124. SE

Differences in survival, growth, and pest resistance of planted South Florida slash pine (Pinus elliottii *Engelm. var.* densa *Little & Dorman) from two sources, two seed sizes, and three seedling grades are reported. Findings indicate the possibility of improvement in survival and early growth of planted South Florida slash pine by careful selection of seed source and seedling grade.*

Bonner, F. T.

1963. Some southern hardwoods can be air-layered. J. Forest. 61: 923. SO

In Mississippi air-layering succeeded in April and June on green ash, sweetgum, and cherrybark oak, and in August on green ash. It failed in all months on Nuttall oak and yellow-poplar. Indolebutyric acid stimulated callus growth but not rooting.

1965. Maleic hydrazide unsuitable for controlling height growth of green ash and Shumard oak seedlings. U. S. Forest Serv. Tree Planters' Notes 70, p. 11. SO

A maleic hydrazide spray (15,000 or 30,000 p.p.m.) prevented nursery seedlings from becoming over-large, but it also prevented the terminals from growing after the seedlings were outplanted.

Boyer, W. D.

1966. Longleaf pine pollen dispersal. Forest Sci. 12: 367-368. SO

A high ratio of pollen drift to deposition and the high level of pollen found in an

open area suggest that Pinus palustris *forests fill the air with pollen that travels for long distances, with density declining mostly through diffusion rather than fallout.*

Bramlett, D. L.

1965. Shortleaf pine seed production in the Piedmont. U. S. Forest Serv. Res. Note SE-38, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

The 10-year records of annual shortleaf pine seedfall throughout the southeastern Piedmont have shown that 3 good seed years occurred. In the Georgia Piedmont, seed crops were more frequent than in the northern portions. The data support the theory that climate as well as the physical soil-site environment influence seed production of trees. Destructive agents, by reducing a good flower crop to a poor seed crop, can obscure the weather effects.

——— and Hutchinson, J. G.

1964. Estimating sound seed per cone in shortleaf pine. U. S. Forest Serv. Res. Note SE-18, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

A prediction equation was derived, $Y = 2.365 + 4.836X$, where Y = number of sound seed per cone and X = number of sound embryos exposed by slicing the cone lengthwise in half.

——— and Hutchinson, J. G.

1965. Pine sawfly larvae destroy shortleaf pine strobili in Virginia. U. S. Forest Serv. Res. Note SE-42, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

During the spring of 1963 a survey of shortleaf pine female flowers revealed that 9.6 percent of the flowers were killed by pine sawfly larvae. The following spring, mortality from sawfly larvae was 3.8 percent. In 1964, the percentage of flower mortality attributable to the sawfly was low. Male strobili were also damaged by sawfly larvae.

Brendemuehl, R. H., and Baker, J. B.

1965. Sectional pole for measuring tree heights. U. S. Forest Serv. Res. Note SO-20, 2 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Details for constructing and using an aluminum pole that is convenient, light, and durable.

Brown, C. L., and McAlpine, R. G.

1964. Propagation of sweetgum from root cuttings. Ga. Forest Res. Counc. Res. Pap. 24, 5 pp. SE

Sweetgum can be successfully propagated from root cuttings. Cuttings taken in mid-June from roots of 3-year-old seedlings and 20-year-old trees were placed upright in a medium composed of a 1-to-1 mixture of sand and decomposed sawdust. By October a high percentage of cuttings had produced both buds and roots. Cuttings from seedlings not only produced more buds from each cutting, earlier, but also produced faster growing shoots than cuttings from the older trees. Success in propagation was over 90 percent for seedling material and ranged from 20 to 93 percent for cuttings from 20-year-old trees. A Kinetin-lanolin paste applied to the upper surface of several rows of cuttings apparently did not stimulate bud formation.

Bryan, W. C.

1965. Testing shortleaf pine seedlings for resistance to infection by *Phytophthora cinnamomi*. U. S. Forest Serv. Res. Note SE-50, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Trees of cone-bearing age originating from grafted stock in a breeding area at Athens, Ga., were carefully control-pollinated, utilizing as pollen sources all clones represented in the orchard. Progeny from these pollinations were grown aseptically and subjected to zoospores of Phytophthora cinnamomi *in test tubes. Progeny of several cross pollinations survived, but the progeny of the crosses readily succumbed. These tests indicate that the progeny of certain parent trees possess a high degree of resistance to* P. cinnamomi.

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1966. Loblolly pine a wise choice on littleleaf sites. Southern Lumberman 213(2656): 174-175. SE

Observations in one plantation each of loblolly and shortleaf pine established 25 years ago on adjoining littleleaf sites in South Carolina, and thinned at the same time in 1960, show differences in susceptibility between the two species to littleleaf disease. Trees in the loblolly stand are now healthy and growing vigorously, while the shortleaf stand is breaking up with many trees dead and dying. These observations substantiate past recommendations to favor loblolly over shortleaf in afforesting or reforesting littleleaf sites.

——— and Zak, Bratislav.

1962. Additional syntheses of mycorrhizae on shortleaf and loblolly pines. Forest Sci. 8: 384. SE

An extension of the list of Hymenomycetes which have been found to form mycorrhizae on shortleaf, loblolly, slash, and longleaf pines.

Burns, R. M.

1962. Southern pines and sweetgums do not

mix. U. S. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 141. SO

After 5 years, loblolly, slash, and shortleaf pines are overtopping sweetgums that were planted in mixture with them on uplands of north Mississippi.

Burns, R. M., and McReynolds, R. D.

1966. Clustered sand pine cones. J. Forest. 64: 812-813. SO

Two large clusters of mature Choctawhatchee sand pine cones were found in a young sandhills plantation.

Burton, J. D.

1962. Bark thickness in Tennessee loblolly plantations. U. S. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 142. SO

Double bark thickness = 0.17 + 0.156 d.b.h.

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1965. Greening up the barren grounds. KTG J. 5(1): 6-7. SO

Planting loblolly, shortleaf, or Virginia pine on stripped coal lands in southeastern Tennessee produced earlier and more satisfactory cover and erosion control than direct-seeding the same species or planting Norway spruce or pitch, eastern white, Austrian, or Scotch pines.

Cade, S. C., and Heikkenen, H. J.

1965. Control of pine tip moths on loblolly pine with systemic insecticides. Ga. Forest Res. Counc. Res. Pap. 32, 4 pp. SE

The ability of several systemic insecticides (Di-syston, Shell-1836, Thimet, Tetram, and Menagon) to control the pine tip moth in loblolly pine seedlings, outplanted trees, and seed orchard trees was tested. Thimet and Di-syston appear to be the most promising.

Campbell, W. A., Darby, S. P., and Barber, J. C.

1962. Fusiform rust, an obstacle to the establishment of grafted slash and loblolly pine seed orchards. Ga. Forest Res. Counc. Res. Pap. 11, 5 pp. SE

Grafts made in nursery beds or greenhouses offer a means of controlling rust and increasing the percentage of successful grafts.

——— Gooding, G. V., Jr., and Haasis, F. A.

1963. The occurrence of *Phytophthora cinnamomi* in Kentucky, North Carolina, Tennessee, and Virginia. U. S. Dep. Agr. Plant Dis. Reporter 47: 924-926. SE

Phytophthora cinnamomi, *the fungus causing littleleaf disease of shortleaf pine, was isolated from soils in littleleaf areas in Tennessee and Kentucky. The fungus is also widely distributed in both diseased and littleleaf-free areas in the Coastal Plain and Piedmont of Virginia and North Carolina.*

Cech, F. C., Barber, J. C., and Zobel, B. J.

1962. Comments on "Who wants tree seed certification and why?" J. Forest. 60: 208-210. SE

Reviews seed certification programs and illustrates need for better methods of marketing tree seed.

Christopher, J. F., and Wahlgren, H. E.

1964. Estimating specific gravity of south Arkansas pine. U. S. Forest Serv. Res. Pap. SO-14, 10 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Specific gravity of the merchantable portion of the bole of loblolly and shortleaf pines can be estimated from increment cores taken at breast height. At slight additional cost, the precision of the estimates can be substantially increased by including such data as age, diameter, and merchantable length.

Clements, R. W.

1962. Louisiana slash pine produce good gum yields. AT-FA J. 25(1): 4-5. SE

Gum yields were comparable with those from other parts of the naval stores region.

Clutter, J. L., and Bennett, F. A.

1965. Diameter distributions in old-field slash pine plantations. Ga. Forest Res. Counc. Rep. 13, 9 pp. SE

Method of predicting diameter distributions in old-field slash pine plantations by age, site, and density schedules, and accuracy tests of the predicted values in comparison with actual distributions. With such data it is possible to: (1) forecast the number of merchantable stems per acre for either pulpwood or sawtimber; (2) predict the number of trees per acre large enough for naval production; (3) determine optimum spacings for multiple-product combinations; and (4) evaluate harvesting costs.

Collins, A. B., III

1964. Longleaf pine seed source planting in Georgia—tenth-year results. U. S. Forest Serv. Res. Note SE-19, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Six seed sources of longleaf pine at age 10 show height growth correlated with latitude or temperature. The greatest difference in height between sources, 4.7 feet, was the difference between the Coastal Plain Alabama and the Piedmont Alabama sources. Since only 0.2 foot separated the Georgia and Texas sources, longitude appears to have little effect on height growth. An average survival of 80 percent for the entire study and average height of 25 feet at age 10 indicate species diversification is practical on suitable sites.

1964. Tenth-year results of loblolly pine seed source planting in Georgia. U. S. Forest Serv. Res. Note SE-20, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
Growth and development of nine seed sources of loblolly pine ranging from Maryland to Texas are compared. Height growth increases as the source moves south and east. Fusiform infection also increases as the source moves south and east, going from a low of 5 percent for the Texas source to 51 percent for the Georgia source. Infection of the Maryland source amounted to only 12 percent.

Coyne, J. F.

1965. Collecting small samples of oleoresin. J. Forest. 63: 700. SO
Screwing bottles and vials directly into tree boles prevents loss of volatile components and enhances gum flow by retarding crystallization.

Croker, T. C., Jr.

1964. Fruitfulness of longleaf trees more important than culture in cone yield. J. Forest. 62: 822-823. SO
Five-year cone production of 60-year-old longleaf pines in south Alabama was influenced more by inherent fruitfulness of individual trees than by fertilization and irrigation.

Derr, H. J.

1963. Brown-spot resistance among F_1 progeny of a single, resistant longleaf parent. Forest Genet. Workshop Proc. 1962: 16-17. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm. SO
The considerable resistance displayed by the wind-pollinated progeny indicates genetic control of this trait and hence the possibility of selection for resistant strains.

1966. Longleaf × slash hybrids at age 7: survival, growth, and disease susceptibility. J. Forest. 64: 236-239. SO
Hybrids planted in central Louisiana are demonstrating desirable characteristics of both parent species. They closely resemble longleaf pine in form and branching habits but start height growth immediately and grow almost as fast as slash pine. They appear less susceptible than their parents to the brown-spot needle blight of longleaf and the fusiform rust of slash pine.

Dorman, K. W.

1962. Forest tree improvement for Georgia: a problem analysis of research needs in forest tree breeding and forest genetics. Ga. Forest Res. Counc. Rep. 9, 79 pp. SE
Comprehensive, long-range program of forest tree breeding and genetics research including racial selection, single tree selection, and several types of hybridization.

1963. How scientists are attacking fusiform rust. Forest Farmer 22(11): 6-8, 16-18. SE
Work of many different investigators on inheritance of resistance to fusiform rust in trees within species, in races, and in hybrids with slash and loblolly pine is summarized.

1963. Planned parenthood for pine trees. Pap. Mill News 66(39): 16, 21. SE
A popularized account of the contributions of genetics studies to applied silviculture and applied tree breeding.

1966. Forest tree improvement research in the South and Southeast. U. S. Forest Serv. Res. Pap. SE-22, 90 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
The amount and scope of research with both softwoods and hardwoods are reported for 36 agencies or combinations of agency and geographic location. There are 305 projects or studies involving 20 forest tree genera and 39 research subjects. Of all investigations, 65 percent are with the genus Pinus, *4 percent with other softwoods, and 31 percent with some 15 hardwood genera. Of the work with* Pinus, *9 percent involves shortleaf pine, 27 percent slash pine, 9 percent longleaf pine, 26 percent loblolly pine, and 29 percent eight other pine species, one variety, one natural hybrid, and* Pinus *in general.*

1966. Research programs with species other than yellow-poplar, sweetgum, cottonwoods, and oaks. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 56-57. SE
A brief account of research on hardwood tree species by 17 research agencies throughout the South.

1966. We can double the volume of slash pine growth. Forest Farmer 26(2): 22-23. *Also in* AT-FA J. 29(3): 6-7, 12. SE
Selection and hybridization of trees with a good combination of desirable traits resulted in a gain in volume growth per unit area of more than 46 percent in young progeny.

Ebel, B. H.

1963. Insects affecting seed production of slash and longleaf pines—their identification and biological annotation. U. S. Forest Serv. Res. Pap. SE-6, 24 pp. Southeast.

Forest Exp. Sta., Asheville, N. C. SE
Insects were collected and reared in northern Florida from 1956 to 1960. Paper contains habitat list of insects found in collected host material; annotated list of insects in host material; key to common insect damage to flowers and cones of slash and longleaf pines.

Ebel, B. H.

1964. The occurrence of *Ernobius granulatus* Leconte in aborted first-year cones of longleaf pine. J. Forest. 62: 404-405. SE
Many dead first-year longleaf pine cones in northeast Florida contained larvae of Ernobius granulatus. *Data indicate that* E. granulatus *is a secondary invader in the already dead cones.*

1965. Control of thrips on slash pine female strobili. J. Forest. 63: 287-288. SE
Heptachlor was tested as a water emulsion for the control of a thrips, Gnophothrips piniphilus *Cwfd., injurious to female strobili of slash pine,* Pinus elliottii *var.* elliottii *Engelm. Thrips injury to strobili was effectively minimized by 0.1 percent spray applied to individual strobili clusters and also by 0.05 percent spray applied periodically to entire trees in combination with the fungicide ferbam.*

1965. The *Dioryctria* coneworms of north Florida pines (Lepidoptera: Phycitidae). Ann. Entomol. Soc. Amer. 58: 623-630. SE
Details the biologies of the three Dioryctria *coneworms as they occur in cones and vegetative parts of* Pinus elliottii *Engelm. and* P. palustris *Mill.*

Farmer, R. E., Jr.

1963. Distilled-water mist chamber for propagating greenwood cuttings. U. S. Forest Serv. Tree Planters' Notes 59, pp. 28-29. SO
Construction and operation.

1964. Cottonwood flowering as related to cold requirement of flower buds. Forest Sci. 10: 296-299. SO
A relatively long exposure to winter temperatures characteristic of the lower Mississippi Valley is required before buds will respond to forcing.

1964. Sex ratio and sex-related characteristics in eastern cottonwood. Silvae Genet. 13: 116-118. SO
Of 551 flowering trees selected at random in the Mississippi Delta, 54 percent were males. Males were insignificantly larger in diameter and significantly taller than females. Sex was not related to form class, stem straightness, branchiness, or specific gravity of the wood.

1965. Mist propagation of juvenile cherrybark oak cuttings. J. Forest. 63: 463-464. SO
Greenwood apical cuttings from 1- to 4-month-old seedlings rooted in 4 weeks under mist, after being treated with indolebutyric acid.

1966. Cottonwood improvement in the lower Mississippi Valley. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 49-52. SO
Reviews silvical characteristics of cottonwood related to development and use of improved stock, patterns of natural variation, and nature of breeding systems currently in use. Initial research indicates broad variation in important characters. Productive breeding systems may vary from simple mass selection and clonal testing to long-range programs of recurrent selection.

1966. Gibberellin-induced growth of dormant sweetgum. U. S. Forest Serv. Res. Note SO-42, 3 pp. Southern Forest Exp. Sta., New Orleans, La. SO
One-percent solutions of GA applied to leaves and buds of dormant seedlings caused growth resumption. Dimethyl sulfoxide (30 percent) and water with Tween 20 were equally effective as GA carriers and were both better than lanolin.

1966. Propagation of sweetgum by softwood stem cuttings. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 123-124. SO
When cuttings from root suckers were rooted under mist, a 1:1 mixture of sand and peat was a better medium than pure sand. Indolebutyric acid (50 p.p.m.) did not stimulate rooting.

1966. Rooting dormant cuttings of mature cottonwood. J. Forest. 64: 196-197. SO
Untreated stem cuttings collected in early February rooted better than those taken in December, January, or early March. Flowering and foliation preceded rooting in March collections and diminished propagation success. Removal of flower buds increased rooting. Tree-to-tree variation in rooting was highly significant, as was the promotive effect of IBA. The overall effect of sex was insignificant.

1966. Variation in time of flowering and seed dispersal of eastern cottonwood in the lower Mississippi Valley. Forest Sci. 12:

343-347. SO

Flowering occurred from early March to early April; differences between trees within stands accounted for 98 percent of the variation. Trees within stands appeared to flower in predictable sequence. Dispersal lasted from mid-May to late August, with most of the variation accounted for by differences among trees.

———— and Wilcox, J. R.

1964. Cottonwood improvement system for commercial planters. U. S. Forest Serv. Res. Note SO-7, 3 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Simple procedure for identifying and propagating superior phenotypes.

———— and Wilcox, J. R.

1965. Specific gravity variation in a lower Mississippi Valley cottonwood population. Third Forest Biol. Conf. Proc., Tech. Assoc. Pulp and Pap. Ind. Pap. 3-3, 8 pp. *Also in* TAPPI 49: 210-211. 1966. SO

The mean was 0.38 and the range 0.32 to 0.46.

———— and Wilcox, J. R.

1966. Variation in juvenile growth and wood properties in half-sib cottonwood families. *In* Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 1-4. North Central Forest Exp. Sta., St. Paul, Minn. SO

Narrow-sense heritability estimates were: height, 0.35; diameter, 0.16; specific gravity, 0.62; fiber length, 0.40.

Gansel, C. R.

1966. Inheritance of stem and branch characters in slash pine and relation to gum yield. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 63-67. SE

Number of crooks per foot, degree of crook, size of branches, and crown width ratio were studied in ortets and their clones. The study proved that high gum yield and good form can readily be combined in a selection and breeding program.

———— and Darby, S. P.

1966. Development of multi-purpose superior slash pine forges ahead. Southern Lumberman 213(2656): 144-145. SE

The Naval Stores and Timber Production Laboratory at Olustee, Florida, has enlisted the cooperation of most of the organizations in the South having superior slash pine selections, to develop a strain of slash pine with superior form, growth rate, timber quality, and gum yielding ability. This article explains how this is being accomplished.

Gooding, G. V., Jr., and Powers, H. R., Jr.

1964. Serological comparison of *Cronartium fusiforme, C. cerebrum, and C. ribicola.* (Abstr.) Phytopathology 54: 622-623. SE

The relationship between three species of Cronartium *was determined serologically, using antigen-antibody reactions in rabbits. All three fungi were found to be closely related, but* C. fusiforme *and* C. cerebrum *contained all antigenic sites of* C. ribicola, *plus one or more sites.* C. fusiforme *contained one or more sites not contained by* C. cerebrum.

Grano, C. X.

1966. An eight-day volumetric pollen sampler. U. S. Forest Serv. Res. Note SO-35, 4 pp. Southern Forest Exp. Sta., New Orleans, La. SO

The pollen sampler described, unlike commonly used stationary adhesive-bearing slides and similar devices, provides accurate, continuous, volumetric estimates of atmospheric pollen load. The sampler is simple to construct.

Grigsby, H. C.

1962. How to propagate plants by air layering. Forests and People 12(3): 22-23. SO

Directions for air-layering pines.

————

1962. Propagation of loblolly pine by cuttings. Plant Propagators Soc. Proc. 11: 33-35. SO

Cuttings made in December have been rooted under mist in a sand-perlite mixture heated to about 75-80° F. IBA helps induce rooting.

————

1964. Fixed-pipe insecticide sprayers protect cones of tall plus pines. J. Forest. 62: 755. SO

An insecticide misting system has been developed for permanent installation in tall trees. In 5 minutes the pipe in a 100-foot tree can be connected to a power sprayer and the spraying completed to control cone-infesting insects. The parts cost about $12.50.

————

1966. Captan aids rooting of loblolly pine cuttings. Int. Plant Propagators' Soc. Proc. 15: 147-150. SO

A combination of captan and IBA produced 40 percent rooting.

Halls, L. K., and Alcaniz, Rene.

1965. Rooting cuttings of browse plants. U. S. Forest Serv. Res. Note SO-25, 2 pp. Southern Forest Exp. Sta., New Orleans, La. SO

In a greenhouse, stem cuttings from American beautyberry, flowering dogwood, black willow, and common greenbrier rooted consistently enough to warrant recommendation for vegetative propagation. Rooting of 11 other species was erratic or poor.

Haney, G. P.

1962. A revised shortleaf pine bibliography. U. S. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 155, 74 pp. SE

Brings Station Paper 48, "Shortleaf Pine Bibliography," up to date.

Hare, R. C.

1964. Indoleacetic acid oxidase. Bot. Rev. 30: 129-165. SO

Survey of recent literature. This enzyme may be important in controlling auxin availability, thereby influencing growth, flower and root initiation, aging, photoperiodic and other photomorphogenic effects, apical dominance, abscission, and development of parasitically induced tumors. Other topics reviewed include distribution of the enzyme, its chemistry and mode of action, factors influencing its activity, and assay techniques.

———

1965. Breaking and rooting of fascicle buds in southern pines. J. Forest. 63: 544-546. SO

Pinching the branch tips forced fascicle buds into active growth, but only 23 of 6,239 active-budded fascicles rooted when treated with a hormone and inserted in perlite under intermittent mist. Species, age, and season strongly influenced both breaking and rooting.

———

1965. Contribution of bark to fire resistance of southern trees. J. Forest. 63: 248-251. SO

Time required to kill cambium in situ with a propane flame was a function of both thickness and thermal properties of the overlying bark; resistance was directly correlated with tree diameter. Of 14 pine and hardwood species longleaf and slash pine were most resistant, and sweetgum, cherry, and holly least resistant.

———

1965. Simple hot stage for studying critical cell temperatures. Can. J. Bot. 43: 777-778. SO

Trials with an easily constructed stage indicate that cells of longleaf pine stem tissue may be more heat-tolerant than cells of white pine.

———

1966. Physiology of resistance to fungal diseases in plants. Bot. Rev. 32: 95-137. SO

Discusses recent findings on such physiological resistance factors as hypersensitivity, phytoalexins, other toxins and inhibitors, phenolic metabolism as related to resistance, and host-parasite nutrition. Also includes literature dealing with metabolic and biochemical changes induced by infection, and the physiology of infection processes.

Harrington, T. A.

1965. Gum production research—a key to increased profits. Nav. Stores Rev. Int. Yearbook 1964: 20-21, 65. SE

Research results are presented that will lead to increased profits. Covered are prolonging gum flow, producing high grade gum, integrating gum and timber production, tree nutrition, and breeding high gum-yielding trees.

Hedlund, Arnold.

1964. Epicormic branching in north Louisiana Delta. U. S. Forest Serv. Res. Note SO-8, 3 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Epicormic branching was found on the second log of 72 percent of the saw-log size hardwoods. It was most frequent in stands with basal areas below 75 square feet per acre.

Heikkenen, H. J.

1964. A *Dioryctria* spp. outbreak and its control in a loblolly-slash pine seed orchard. J. Forest. 62: 577-579. SE

A destructive cone and seed insect, Dioryctria spp., was discovered infesting fusiform cankers in a loblolly-slash pine seed orchard in Georgia. Control of the larvae was achieved with 1 percent gamma solution of BHC in a nonphytotoxic oil.

Henry, B. W.

1963. Genetics and paper. Pap. Mill News 86 (39): 12-13. SO

In years to come, genetics, and its manipulation through tree breeding, will be contributing to a stronger paper industry.

——— Dorman, K. W., and Wakeley, P. C.

1962. Forest genetics publications by the Southeastern and Southern Forest Experiment Stations. U. S. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 192, 27 pp. SO-SE

Annotated bibliography of papers on forest genetics, forest tree breeding, and several closely related fields.

——— and Jewell, F. F.

1963. Resistance of pines to southern fusiform rust. World Consultation on Forest Genet. and Tree Impr., FAO, Stockholm, Sweden, August 23-30, 1963. 4 pp. SO

Resistance has been demonstrated from two sources: the shortleaf species and individual slash pines.

——— and Neelands, R. W.

1963. Institute of Forest Genetics revisited. Forest Farmer 22(8): 16-17, 26. SO

Summary of progress since the Institute was established in 1955.

Hepting, G. H.

1964. Damage to forests from air pollution. J. Forest. 62: 630-634. SE

Past air pollution damage was mainly caused by SO_2 and F from smelting. Current damage is also the result of oxidant from photochemical smog, possibly natural ozone, and certain industrial stack gases. Means of detecting pollution by use of sensitive clonal lines of white pine have been developed.

Hoekstra, P. E.

1965. A simple, inexpensive pollen trap. U. S. Forest Serv. Res. Note SE-40, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Trap employing clear cellulose tape proved superior to vaseline-coated glass slides for pollen trapping and identification.

Hutchinson, J. G., and Bramlett, D. L.

1964. Frost damage to shortleaf pine flowers. J. Forest. 62: 343. SE

Flowers showed evidence of damage 5 days after a spring frost and were completely necrotic after 11 days. Female flowers are apparently most sensitive to frost damage during the receptive stage.

Ike, A. F., Jr.

1962. Root collar diameter is a good measure of height growth potential of sycamore seedlings. U. S. Forest Serv. Tree Planters' Notes 54, pp. 9-11. SE

Mean first-year height growth of seedlings with root collars of various diameters.

———

1966. Sycamore produces viable seed after six years. U. S. Forest Serv. Res. Note SE-62, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Three of five 1-year-old, nursery-grown sycamore seedlings, planted as shade trees in Athens, Georgia, produced viable seed 5 years after transplanting. These observations suggest that selected sycamore trees can be stimulated to produce seed at early ages.

Jewell, F. F.

1963. How can genetic control of diseases aid the forest manager? Seventh Southern Forest Tree Impr. Conf. Proc. 1963: 25-26. SO

Disease-resistant trees may be among the earliest practical results of forest genetics research.

———

1966. Disease and insect resistance research in Southern United States. *In* Breeding Pest-Resistant Trees, pp. 59-60. Oxford and New York: Pergamon Press. SO

Considerable research is under way, and developments can be expected.

———

1966. Inheritance of rust resistance in southern pines. *In* Breeding Pest-Resistant Trees, pp. 107-109. Oxford and New York: Pergamon Press. SO

In slash pine, natural resistance to Cronartium fusiforme *apparently is controlled by a dominant gene, and susceptibility seems completely recessive. In crosses with slash pine, shortleaf pines appear to vary considerably in ability to transmit resistance.*

——— and Eleuterius, L. N.

1963. Amphiphyllous uredia and telia of southern fusiform rust. U. S. Dep. Agr. Plant Dis. Reporter 47: 65. SO

Sori have been found on the upper as well as the lower surfaces of oak leaves.

——— and Mallett, S. L.

1964. Resistance to fusiform rust in slash pine as shown by artificial inoculation. Phytopathology 54: 1294. SO

Individual slash pines vary in rust susceptibility and transmit their resistance to progeny, but progeny testing is necessary to determine the resistance or susceptibility of the parent.

——— and Walker, N. M.

1965. Normal and abnormal mycelial characteristics of *Cronartium quercuum* in shortleaf pine. Phytopathology 55: 1325-1327. SO

The fungus has intercellular, septate, mostly uninucleate hyphae averaging 3.5μ in width, and usually unicellular, uninucleate, unbranched haustoria averaging $15.6 \times 3.5\mu$. Binucleate hyphal cells and haustoria were often observed, however, and two-celled haustoria occurred occasionally; branched ones were rare. All tissues of the affected areas were invaded.

Johnson, R. L., and Krinard, R. M.

1963. Planted yellow-poplar outperforms six other species on loess sites. U. S. Forest Serv. Tree Planters' Notes 61, pp. 11-12. SO

After 2 years in plantation, yellow-poplar trees averaged two to six times taller than southern red oak, cherrybark oak, water oak, swamp chestnut oak, Shumard oak, and sweetgum.

Jones, E. P., Jr.

1966. Performance of some non-native pines—ponderosa, pitch, pinyon, Scotch, and Corsican. U. S. Forest Serv. Tree Planters' Notes 77, pp. 4-5. SE

Yearly survival and height data for the six named species and varieties are briefly reported from observation plots in south-central Georgia. Pitch pine (Pinus rigida *Mill.) was the best performer at age 4, with 75 percent survival*

and 2.15 feet in average height. All trial species compare unfavorably with native slash (P. elliottii Engelm.) and longleaf (P. palustris Mill.) pine.

Kais, A. G., and Walkinshaw, C. H.
1964. White-spored strain of *Cronartium fusiforme*. U. S. Dep. Agr. Plant Dis. Reporter 48: 686. SO
The first report of a recognizable, consistent variation in the fusiform rust fungus.

Ketcham, D. E., and Bethune, J. E.
1963. Fire resistance of South Florida slash pine. J. Forest. 61: 529-530. SE
South Florida slash pine seedlings are more fire resistant than typical slash pine seedlings.

Kormanik, P. P., and Brown, C. L.
1964. Origin of secondary dormant buds in sweetgum. U. S. Forest Serv. Res. Note SE-36, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
Most dormant trace buds in deciduous trees are laid down by apical meristems on newly elongating shoots. These supernumerary buds, arising within the basal scales of axillary buds, remain visible for several years, but are slowly embedded in the periderm. Observations indicate that in sweetgum the majority of these buds branch during succeeding years while still covered by the periderm and give rise to numerous additional buds. These are commonly referred to as "Secondary dormant trace buds." Apparently most of these buds are of scale origin.

——— and Hoekstra, P. E.
1963. A comparison of loblolly, white, Virginia, and shortleaf pine in the Virginia Piedmont. U. S. Forest Serv. Res. Note SE-11, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
Loblolly and white pine were taller than either Virginia or shortleaf pine after 16 growing seasons.

——— and Porterfield, E. J.
1966. Rooting yellow-poplar cuttings. Forest Farmer 26(2): 24, 41-42. SE
Epicormic branches can be induced on yellow-poplar to furnish a large number of cuttings for vegetative propagation. Selected trees should be partially girdled 4 to 6 weeks before the buds begin to swell. The resulting epicormic branches are then cut from the tree and placed in a mist bed to develop roots.

——— Steinbeck, Klaus, and Brown, C. L.
1966. A new variety of sweetgum. U. S. Forest Serv. Res. Note SE-55, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
A dwarf variety of sweetgum near Athens, Georgia, is about 10 feet tall and has been reproduced vegetatively.

Kraus, J. F.
1963. The Olustee Arboretum—performance of 67 species of forest trees. U. S. Forest Serv. Res. Pap. SE-4, 47 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
The Olustee Arboretum was started in north Florida in 1954 as an introduction and breeding garden of exotic pines used by the naval stores industry. Survival and growth are described. Only a very few species grew well.

———
1965. Conversion of oleoresin yields from short-season microchipping to full-season yields from standard chipping. U. S. Forest Serv. Res. Note SE-48, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
Reasonably good correlations between oleoresin yields obtained from short-season microchipping and yields from full-season standard chipping permitted the development of conversion factors for use in the comparison of clones or progenies of slash pine.

——— and Squillace, A. E.
1964. Inheritance of yellow oleoresin and virescent foliage in slash pine. Silvae Genet. 13: 114-116. SE
Selfing and outcrossing of a tree producing yellow oleoresin showed that this trait was inherited as a homozygous recessive, but the number of genes involved has yet to be determined. Controlled breeding on two other trees having virescent foliage showed that this trait was also inherited but the exact mode of inheritance could not be determined. The potentiality of these aberrant genotypes in forest genetics and physiology studies is discussed.

———and Squillace, A. E.
1964. Selfing vs. outcrossing under artificial conditions in *Pinus elliottii* Engelm. Silvae Genet. 13: 72-76. SE
Under artificial test conditions, the degree of self-fertility, as expressed by the numbers of seedlings produced per cone varied greatly among seven trees but averaged about 18 percent of cross-fertility. When using mixtures of self and outcross pollens on three mother trees having gene markers (yellow oleoresin or virescent foliage), the degree of selfing was not greatly different from expectation based on their respective self-fertilities. The results suggested that the degree of selfing in seed orchards will depend greatly on the number of clones used and on the degree of

self-fertility of the clones. A slash pine orchard containing at least 20 clones will probably produce only a slightly greater proportion of selfs than that which occurs in natural stands.

Langdon, O. G.

1963. Growth patterns of *Pinus elliottii* var. *densa*. Ecology 44: 825-827. SE

Diameter growth occurs over a period of 10 months, peaking in both spring and fall at about the time of the vernal and autumnal equinoxes.

1963. Range of South Florida slash pine. J. Forest. 61: 384-385. SE

Revision of a previously published range map shows that this species occurs inland in south-central Florida.

Larson, P. R., Duffield, J. W., Dorman, K. W., and others (Subcommittee of TAPPI Forest Biology Committee).

1962. The influence of environment and genetics on pulpwood quality: an annotated bibliography. TAPPI Monogr. Ser. 24, 316 pp. SE

A comprehensive review of world literature.

McAlpine, R. G.

1963. A comparison of growth and survival between sycamore seedlings and cuttings. U. S. Forest Serv. Res. Note SE-9, 1 p. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Sycamore seedlings survive better, and when fertilized, outgrow cuttings.

1964. A method for producing clones of yellow-poplar. J. Forest. 62: 115-116. SE

Yellow-poplar is generally considered difficult to root, and even more difficult to establish successfully from rooted stem cuttings. Cuttings taken from stump sprouts of 7-year-old trees, however, rooted well under mist (63 to 85 percent), survived, and grew vigorously when transplanted. Rooted cuttings can be outplanted by clones, allowed to grow under intensive culture to a 2-inch root collar diameter, then cut and allowed to sprout. Cuttings multiplied from these sprouts may find value as clonal material to be used in studies dealing with site requirements, nutrition, and physiology where control of genetic variability is desirable.

1966. Vegetative propagation methods for hardwoods. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 14-20. SE

Latest techniques for grafting, layering, rooting of cuttings, and budding of root cuttings. The method chosen depends upon the objective, species, and age of tree to be propagated.

Brown, C. L., Herrick, A. M., and Ruark, H. E.

1966. "Silage" sycamore. Forest Farmer 26(1): 6-7, 16. SE

A new concept in growing and harvesting pulpwood is presented. Sycamore, planted at close spacings, may be harvested while relatively small, using an ordinary silage harvester. Successive harvests of resulting coppice can produce high yields of fiber at amazingly short rotations. Pulping tests of young sycamore trees with bark and leaves included have shown promise.

McClurkin, D. C.

1965. Diameter growth and phenology of trees on sites with high water tables. U. S. Forest Serv. Res. Note SO-22, 4 pp. Southern Forest Exp. Sta., New Orleans, La. SO

On a site where the water table always was within the root zone, thinning had little effect on diameter growth of white ash or sweetgum but increased the growth of baldcypress. Thinning did not extend duration of growth into the fall, nor was growth related to seasonal fluctuations in the water table. In ash and sweetgum, growth initiation seemed related to soil temperature; in baldcypress, to day length.

McGee, C. E.

1964. Species test in the sandhills. Forest Farmer 24(2): 10, 15. SE

Slash pine has been most widely planted in the sandhills because of its excellent early growth. The fifth-year results of comparison of 11 species planted on Americus and Lakeland deep sandy soils showed that loblolly pine and redcedar are two other promising species for these soils. The loblolly pine growth and survival have equaled slash pine, and redcedar shows promise as a source for Christmas trees.

McLemore, B. F.

1962. Predicting seed yields of southern pine cones. J. Forest. 60: 639-641. SO

Formulae have been developed for estimating yields of longleaf, slash, and loblolly pine cones from the number of full seeds cut through when cones are sliced longitudinally with a sharp knife.

1964. Light during stratification hastens dark-germination of loblolly pine seed. Forest Sci. 10: 348-349. SO

The amount of light that Pinus taeda *L. seeds require for germination is reduced by cold moist stratification aimed at*

breaking seed dormancy. Irradiation with white light during stratification further fulfills the light requirement.

McLemore, B. F.

1965. Pentane flotation for separating full and empty longleaf pine seeds. Forest Sci. 11: 242-243. SO

Full and empty seeds can be separated with high precision by flotation in n-pentane.

———— and Derr, H. J.

1965. Longleaf pine cone maturity is independent of pollination date. Silvae Genet. 14: 133. SO

Period of seed development is constant for individuals but varies between trees. The order of cone ripening is nearly identical from year to year.

Maple, W. R.

1965. Forest species compared in Ozark plantations. U. S. Forest Serv. Res. Note SO-28, 2 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Fifteen-year results on abandoned fields indicate that native species should continue to be planted, but that loblolly pine, yellow-poplar, and Virginia pine merit further study.

Matthews, F. R.

1964. Some aspects of the biology and the control of southern cone rust. J. Forest. 62: 881-884. SE

Cone rust on southern pines was followed from development of basidiospores on evergreen oaks to infection of female strobili. Hydraulic spray applications of ferbam at 5-day intervals gave control in slash pine seed orchards.

Mergen, F., Snyder, E. B., and Burley, J.

1966. Variation in coastal and insular slash pine of Mississippi and Alabama. Amer. Midland Natur. 76: 482-495. SO

Variations from north to south were found among 27 needle, twig, bud, and cone characters from 11 island, coastal, and inland collections of P. elliottii *Engelm.*

———— Stairs, G. R., and Snyder, E. B.

1963. Microsporogenesis in *Pinus echinata* and *Pinus taeda*. Silvae Genet. 12: 127-129. SO

Photomicrographs of major stages, and phenology in southern Mississippi.

———— Stairs, G. R., and Snyder, E. B.

1965. Natural and controlled loblolly × shortleaf pine hybrids in Mississippi. Forest Sci. 11: 306-314. SO

Means for most of 20 vegetative characters of young F_1 hybrids were intermediate to those of the interplanted parental checks, while ranges overlapped. Separation of hybrids and parents was obtained by combining certain vegetative characters in pictorialized scatter diagrams. Length of male strobili was outstandingly discriminative as a single character.

Merkel, E. P.

1962. The number of larval instars of *Dioryctria abietella* (D. and S.) (Lepidoptera: Phycitidae) in Florida. Can. Entomol. 94: 1005-1007. SE

Methods for determining larval instars of D. abietella *and comparison of Florida and Canadian larvae head-capsule width data for this insect.*

————

1962. The toxicity of insecticides to larvae of *Dioryctria abietella* in laboratory screening tests. J. Econ. Entomol. 55: 682-684. SE

Laboratory procedures for evaluating toxicity of 13 insecticides to last-instar larvae of the coneworm, D. abietella, *and concentration-mortality data.*

————

1964. Hydraulic spray applications of insecticides for the control of slash pine cone and seed insects. U. S. Forest Serv. Res. Pap. SE-9, 7 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Slash pines up to 40 feet in total height were protected from coneworm attack with BHC or Guthion. DDT did not give satisfactory protection from coneworms. Of the three tested, Guthion was the only insecticide which controlled the seedworm. A spray schedule is given for the control of coneworms and the seedworm on slash pine in north Florida.

———— Squillace, A. E., and Bengtson, G. W.

1966. Evidence of inherent resistance to *Dioryctria* infestation in slash pine. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 96-99. SE

Infestation of mature slash pine cones by Dioryctria abietella *and* Dioryctria amatella *was recorded on 10 mature slash pines in a seed production area at Olustee, Florida, over a 3-year period. The study suggests genetic control over coneworm attack and attack by* D. amatella.

———— and Yandle, D. O.

1965. Mist blower applications of insecticides for cone insect control on slash pine. U. S. Forest Serv. Res. Note SE-52, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

A field experiment to compare the effectiveness of hydraulic syrays with mist blower applications of insecticides for cone insect control showed that cone infestation by Dioryctria *spp. was sig-*

nificantly lower on all sprayed trees than on unsprayed trees at midseason and at cone harvest. The mist blower application of a 1.0-percent Guthion water emulsion gave significant control of the seedworm, Laspeyresia anaranjada. *Data are presented on comparative costs and seed yields between treatments.*

Namkoong, Gene.

1965. Comments on "A one-parent progeny test and seed orchard for the improvement of red pine." J. Forest. 63: 473-474. SO

In terms of genetic gain alone, clonal seed orchards can be highly superior to wind-pollinated seedling orchards.

———

1966. Application of Nelder's designs in tree improvement research. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 24-37. SO

The systematic designs make it possible to sample a range of spacings economically and with limited variation in the shape of the individual tree's growing space.

———

1966. Family indices for seed-orchard selection. *In* Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 7-12. North Central Forest Exp. Sta., St. Paul, Minn. SO

Data on the performance of relatives can be easily used for significant improvements in genetic gain by selection. In progeny-tested clonal seed orchards, at least two sources of data for selection can be combined in an index for gains of more than 100 percent over selection on progeny data alone. In seedling seed orchards, three sources of data are usable, and gain from index over tandem selection may be more than 100 percent.

———

1966. Inbreeding effects on estimation of genetic additive variance. Forest Sci. 12: 8-13. SO

The value of open-pollinated seed for estimating the additive variance among families is diminished by a probable bias due to natural inbreeding. Several factors including nonadditive genetic effects, relatedness of neighboring trees, and failure to recognize any inbreeding tend to foster an overestimate of the true additive variance.

———

1966. Statistical analysis of introgression. Biometrics 22: 488-502. SO

Measurements of introgression may be made on scales established by principal components, canonical correlation vectors, discriminant functions, hybrid indices, and a proposed distance analysis. The distance analysis developed is the most sensitive scale used. When the methods were used on a set of data from introgression of two pine species, the failure of some of the assumptions was such as to lead to some differences in biological conclusions.

——— Snyder, E. B., and Stonecypher, R. W.

1966. Heritability and gain concepts for evaluating breeding systems such as seedling orchards. Silvae Genet. 15: 76-84. SO

Principles and formulas for comparing various breeding systems. No one breeding system appears superior under all variations of heritabilities and selection intensities.

Neelands, R. W.

1962. A hundred thousand pedigrees. Southern Lumberman 205(2561): 129-130. SO

Research at the Institute of Forest Genetics. Also see entry under Southern Forest Experiment Station.

Nelson, T. C.

1964. Diameter distribution and growth of loblolly pine. Forest Sci. 10: 105-114. SE

The relationships between cubic-foot growth and diameter distribution, and residuals from cubic-foot growth equations and diameter distribution were tested on 103 plots of even-aged, managed loblolly pine. A series of diameter distribution characterizations using mathematical expressions of the entire distribution curve, mathematical expressions of individual attributes of the diameter distribution curve, and biological characterizations of it were computed. All of the 15 expressions of diameter distribution tested were rejected as useful expressions for characterizing merchantable cubic-foot growth. The probability of markedly reducing unexplained variation in merchantable cubic-foot growth in managed, even-aged loblolly pine with characterizations of diameter distribution is small.

Neunzig, H. H., Rabb, R. L., Ebel, B. H., and Merkel, E. P.

1964. Larvae of the genus *Dioryctria* (Lepidoptera: Phycitidae) in the Southeastern United States. Ann. Entomol. Soc. Amer. 57: 693-700. SE

Detailed descriptions, supplemented by illustrations and key, are presented for the last-instar larvae of Dioryctria abietella, pygmaeella, disclusa, clarioralis, amatella, and zimmermani.

Platt, W. D., Cowling, E. B., and Hodges, C. S., Jr.
1965. Resistance of coniferous root wood and stem wood to decay by *Fomes annosus*. (Abstr.) Phytopathology 55: 130-131. SE
Decay resistance of sapwood from roots and stems of eight coniferous species was determined in a complete factorial experiment using 16 tissue isolates of Fomes annosus *from the same eight species. Among the wood species tested,* Juniperus virginiana *was the most resistant;* Pinus resinosa, P. virginiana, *and* P. palustris *were intermediate; and* P. echinata, P. elliottii *var.* elliottii, P. strobus, *and* P. taeda *were least resistant. Stem wood of all species was more resistant than root wood.*

Rodenbach, R. C., and Olson, D. F., Jr.
1962. Five-year survival and height growth of several planted hardwood species in the North Carolina Piedmont. Furniture, Plywood and Veneer Counc. of the N. C. Forest. Assoc., Inc., Rep. 10, 5 pp. SE
A majority of the 17 species tested in two demonstration arboretums showed good survival, but height growth was satisfactory on only a few species.

Rogerson, T. L.
1964. Estimating foliage on loblolly pine. U. S. Forest Serv. Res. Note SO-16, 3 pp. Southern Forest Exp. Sta., New Orleans, La. SO
Weight of foliage on trees in a 25-year-old plantation in north Mississippi was related to tree diameter. The weight in turn afforded ready estimates of the number of needles and fascicles, whose size and weight were found to be independent of tree diameter.

Saucier, J. R., and Taras, M. A.
1966. Wood density variation among six longleaf pine seed sources grown in Virginia. J. Forest. 64: 463-465. SE
Longleaf pine from six seed sources were grown in Virginia and examined for specific gravity differences after eight growing seasons. One seed source from Florida had significantly lower specific gravity than other sources tested. Additional data indicated that the Florida seed source was less frost resistant than other sources; this difference may have been associated with its low specific gravity. Although data indicated a racial difference in specific gravity, a valid conclusion cannot be made in view of a confounding with incompatible environment. When the Florida seed source was omitted from the analysis of variance, there was no significant difference in specific gravity of five seed sources.

Schmitt, Dan, and Namkoong, Gene.
1965. Pine species in the Harrison Experimental Forest Arboretum. U. S. Forest Serv. Res. Pap. SO-18, 18 pp. Southern Forest Exp. Sta., New Orleans, La. SO
Pines of 45 species, five native and 40 nonnative, were planted between 1955 and 1962. Of the nonnatives, 20 failed, and none have approached slash pine in growth, although some have become reproductively mature.

Shelbourne, C. J. A., and Namkoong, Gene.
1966. Photogrammetric technique for measuring bole straightness. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 131-136. SO
Straightness and lean parameters of a tree are described and measured on two photos taken at right angles to each other.

Shoulders, Eugene.
1965. Seed origin affects longleaf pine in Louisiana plantation. U. S. Forest Serv. Res. Note SO-19, 3 pp. Southern Forest Exp. Sta., New Orleans, La. SO
Trees representing seed sources with mean annual temperatures of 60 to 67° F. had best 5-year survival. Those from regions with 17 to 20 inches of rain from January through April made the most height growth.

Sluder, E. R.
1963. A white pine provenance study in the southern Appalachians. U. S. Forest Serv. Res. Pap. SE-2, 16 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE
White pine seedlings of southern origin were taller on the average than seedlings of northern origin after 3 years in plantations on three sites in the southern Appalachians.

1964. Quality of yellow-poplar planting stock varies by mother tree and seedbed density. U. S. Forest Serv. Tree Planters' Notes 65, pp. 16-19. SE
Seedling size affects survival of planted yellow-poplar. Little is known, however, of the effect of root pruning on survival of yellow-poplar seedlings or of the effect of maternal parent on survival and phenotype of progeny groups. Such information would be valuable to those wishing to plant yellow-poplar for forestry purposes. This study showed that 1-0 seedling size of yellow-poplar varied with nursery bed density and by maternal parent tree. Higher bed densities produced too many small seedlings. Optimum density for this study was 25 to 30 seedlings per square foot. Some progeny groups had greater percentages of small seedlings than did others. First-year survival of planted seedlings also varied by progeny group,

but not by root-pruning treatment. As an aid to nursery practices and tree improvement, evaluation of progeny will be made when the trees are larger.

———

1966. Hand-pollinate yellow-poplar without climbing. U. S. Forest Serv. Res. Note SE-54, 7 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Limbs are shot from mature trees, and dormant twigs with flower buds are grafted onto growing seedling rootstocks. Flowers are pollinated on the grafts as they bloom.

Smith, L. F.

1966. Early flowering in longleaf pine. J. Forest. 64: 198-199. SO

One tree bore female flowers after its fourth year in plantation, many trees had male or female flowers after the fifth year. Annual cultivation appears to promote early flowering in longleaf.

——— and Smith, H. D.

1963. Growth of slash, loblolly, and longleaf pines on cultivated sites. U. S. Forest Serv. Tree Planters' Notes 59, pp. 1-2. SO

Cultivation and brown-spot control shortened the grass stage of the longleaf trees; by age 4 years their heights averaged 7.3 feet, about the same as third-year heights of slash and loblolly.

——— Snyder, E. B., and Scarbrough, N. M.

1963. Care of pine seedlings used in breeding at Institute of Forest Genetics. U. S. Forest Serv. Res. Note SO-2, 4 pp. Southern Forest Exp. Sta., New Orleans, La. SO

When grown in pots for a few months between lifting and outplanting, and cultivated and kept free of pests in plantation, longleaf seedlings averaged 95 percent in first-year survival and 94 percent of the survivors began height growth the second year.

Smith, R. F.

1963. Preferential attack by *Dendroctonus terebrans* on *Pinus elliottii*. J. Econ. Entomol. 56: 817-819. SE

Incidence was markedly greater on previously attacked than on unattacked trees.

Snow, G. A., and Kais, A. G.

1966. Oak leaf development during aecial sporulation of *Cronartium fusiforme*. U. S. Dep. Agr. Plant Dis. Reporter 50: 388-390. SO

Aeciospore release is well synchronized with the presence of susceptible young oak leaves in Mississippi. Aeciospores and susceptible water oak leaves occurred at the same time for 47 days in 1964 and 39 days in 1965.

——— and Roncadori, R. W.

1965. Oak leaf age and susceptibility to *Cronartium fusiforme*. U. S. Dep. Agr. Plant Dis. Reporter 49: 972-975. SO

Leaves became progressively more resistant as they matured. Uredial development was restricted before telial.

Snyder, E. B.

1966. Lattice and compact family block designs in forest genetics. *In* Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 12-17. North Central Forest Exp. Sta., St. Paul, Minn. SO

Lattices are advocated for large tests that include many genotypes. Computer shortcuts are cited for layouts and analysis, including analyses with missing plots. Compact family blocks are suggested for experiments such as provenance tests, where progenies from individual trees are kept separate within sources. In 12 of 17 U. S. forestry experiments these designs were over 10 percent more efficient than randomized blocks.

——— and Allen, R. M.

1963. Sampling, nursery, and year-replication effects in a longleaf pine progeny test. Forest Genet. Workshop Proc. 1962: 26-27. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm. SO

Ten-year results from a comprehensive test illustrated the possibility of error or inefficiency from unrepresentative sampling, persisting effects of nursery environment, and indiscriminate replication by years.

——— and Squillace, A. E.

1966. Cone and seed yields from controlled breeding of southern pines. U. S. Forest Serv. Res. Pap. SO-22, 7 pp. Southern Forest Exp. Sta., New Orleans, La. SO-SE

Over a 10-year period, survivals of cones from controlled cross pollinations were less than 40 percent, and seed yields per cone averaged about half those from wind pollinations. Self pollinations produced about 15 percent as much seed as cross pollinations. Interspecific pollinations were generally less productive than intraspecific pollinations.

——— Squillace, A. E., and Hamaker, J. M.

1966. Pigment inheritance in slash pine seedlings. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 77-85. SO-SE

Generalized findings were: (1) gene action similar to that for inbreeding depression underlying susceptibility to needle chlorosis; (2) disturbed monofactorial segregation ratios and non-

allelism for albina-type mutants; (3) additive polygenic action and clinal variation for hypocotyl colors. A new method for estimating heritabilities and combining abilities utilizes combining abilities for each stand by averaging the wind-pollinated phenotypic values of the sampled trees per stand. Open pollinated progeny tests were highly efficient.

Sorensen, F. C.

1964. Inheritance of needle and bud characteristics of slash pine. Silvae Genet. 13: 109-114. SE

The following characteristics were shown to be strongly inherited: needle length, needle bundle volume, fascicle, sheath length, needle divergence, and bud scale length. Genetic control of number of needles per fascicle was slight.

Southern Forest Experiment Station.

1962. The Institute of Forest Genetics. U. S. Forest Serv. Southern Forest Exp. Sta., 38 pp. SO

Statement of the Institute's aims, plus synopses of its main studies.

Squillace, A. E.

1962. Breeding for high gum yield in slash pine. Nav. Stores Rev. 72(9): 7, 17. SE

Selection and controlled crossing have created a strain with over twice the average yield.

1964. Finer pines aid turpentiners. Southern Lumberman 209(2609): 95-96. *Also in* Nav. Stores Rev. 75(5): 4, 15. 1965. SE

Progress in the development of slash pines with high gum yield and superiority in other desirable characteristics is briefly summarized.

1966. Combining superior growth and timber quality with high gum yield in slash pine. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 73-76. SE

Data show that high gum yield can be combined with superior growth and timber quality. A seed-production area and several clonal orchards are being established with this objective.

1966. Geographic variation in slash pine. Forest Sci. Monogr. 10, 56 pp. SE

Twelve morphological traits were studied in cones, seeds, and foliage from the parents, and 13 morphological and physiological traits were studied in the seedlings. Most traits showed appreciable stand-to-stand variation. The patterns of stand variation differed among traits, but most were characterized by gradual changes between one or more "highs" or "lows." Many of the patterns contained a latitudinal gradient through Florida with a trend reversal in the "north-central" area (extreme south Georgia and north Florida).

1966. Planning tree improvement research at Olustee. AT-FA J. 28(5): 11-13. SE

Describes techniques, major accomplishments, and future work plans in developing high gum yielding and otherwise superior slash and longleaf pines.

1966. Racial variation in slash pine as affected by climatic factors. U. S. Forest Serv. Res. Pap. SE-21, 10 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

Most slash pine traits show definite geographic patterns caused by environmental modification and genetic adaptation. The patterns are usually characterized by gradients existing between extreme types located at fringes or within interior portions of the species' range. A zone of optimum environment seems to occur, within which native trees are phenotypically and genetically superior in growth rate in comparison to trees in less favorable environments.

——— Echols, R. M., and Dorman, K. W.

1962. Heritability of specific gravity and summerwood per cent and relation to other factors in slash pine. TAPPI 45: 599-601. SE-SO

Estimates of the heritability of specific gravity were roughly twice those of summerwood percent. Relations of between-tree variation in specific gravity to d.b.h. and to total height were weak to moderately strong, but appeared mainly phenotypic rather than genetic. Specific gravity was weakly related to summerwood percent—hence modest gains in specific gravity are possible through selection and breeding.

——— and Fisher, G. S.

1966. Evidences of the inheritance of turpentine composition in slash pine. *In* Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 53-60. North Central Forest Exp. Sta., St. Paul, Minn. SE

Individual tree differences and racial variation occur in the content of some gum constituents of slash pine. These differences are strongly inherited, and reveal opportunities to breed for specific gum composition, to capitalize on geographic variation in commercial gum operations, and to develop a useful tool in pine genetics research.

———— and Kraus, J. F.

1963. Effects of inbreeding on seed yield, germination, rate of germination, and seedling growth in slash pine. Forest Genet. Workshop Proc. 1962: 59-63. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm. SE

Sound seed yields, germination, rate of germination, and first-year total height decreased with increasing intensity of inbreeding.

———— and Kraus, J. F.

1963. The degree of natural selfing in slash pine as estimated from albino frequencies. Silvae Genet. 12: 46-50. SE

Natural selfing for 11 trees varied from 0 to 27 percent, nine of the trees showed 5 percent or less selfing, while two of them showed 23 to 27 percent, respectively.

———— and Silen, R. R.

1962. Racial variation in ponderosa pine. Forest Sci. Monogr. 2, 27 pp. SE

Analyses of two studies—one of 30 and the other 45 years' duration—verify apparent differences in growth rate, and correlate them with geographic and climatic factors.

Steinbeck, Klaus.

1966. Site, height, and mineral nutrient content relations of Scotch pine provenances. Silvae Genet. 15: 42-49. SE

Describes the effect of widely divergent seedlot origin and site on the foliar levels of 12 minerals. Demonstrates significant among-seedlot differences in the accumulation of foliar N, P, Na, Mg, and B and relates nutrient content to differences in current internode growth. Emphasizes efficiency of nutrient utilization and proposes pathways through which genetic differences may be expressed in growth.

———— and McAlpine, R. G.

1966. Inter- and intra-specific differences in the root respiration rates of four hardwood species. Forest Sci. 12: 473-476. SE

The respiration rates of root tips from clonal propagules of yellow-poplar, red maple, weeping willow, and black willow were determined manometrically. One clone of black willow differed significantly from the other clones in that species, but no significant intra-specific differences were found among randomly selected clones of the other three species. The root respiration rates of red maple and weeping willow did not differ significantly; all other species showed significant differences. The average Q_{O_2} for yellow-poplar was 3.78, for red maple 5.14, for weeping willow 5.59, and for black willow it was 6.44.

Stransky, J. J., and Duke, W. B.

1964. Shelter for testing drought-hardiness of planted southern pine seedlings. U. S. Forest Serv. Res. Note SO-11, 4 pp. Southern Forest Exp. Sta., New Orleans, La. SO

A plastic-covered shelter simulates drought severe enough to cause seedling mortality. Air and soil temperatures, and relative humidity, are but slightly higher under the shelter than outside it.

———— and Wilson, D. R.

1964. Terminal elongation of loblolly and shortleaf pine seedlings under soil moisture stress. Soil Sci. Soc. Amer. Proc. 28: 439-440. SO

Height growth slowed when soil moisture tensions rose above 2 atmospheres and stopped when tensions exceeded 3.5 atm. Moisture content and water deficit of the leaves changed little before growth stopped.

———— and Wilson, D. R.

1966. Pine seedling survival under simulated drought. U. S. Forest Serv. Res. Note SO-30, 2 pp. Southern Forest Exp. Sta., New Orleans, La. SO

Soil moisture was depleted less rapidly from scalped plots than from those in sod, and planted pines survived better on the scalped sites. Shortleaf survived the drought best, then loblolly and slash pine.

Switzer, G. L., and Wells, O. O.

1964. Seed origin important in pine plantings. Miss. Farm Res. 27(5): 3. *Also as* Geographic seed origin and early performance of loblolly pine on the northeast Mississippi Experimental Forest. Miss. Agr. Exp. Sta. Inform. Sheet 850, 2 pp. SO

In a plantation in north-central Mississippi, trees from seed collected to the south and west have shown better volume growth and rust resistance than trees from seed collected in the eastern and central part of the loblolly pine range.

Thames, J. L.

1962. Loblolly best but seed source important in erosion-control plantings in north Mississippi. U. S. Forest Serv. Tree Planters' Notes 55, pp. 21-22. SO

Loblolly outgrew Virginia, shortleaf, and sand pine. Four loblolly seed sources were represented; the Lost Pines of Texas seemed best, northwest Georgia and east Texas were intermediate, and trees from seed collected in southern Arkansas grew the slowest.

————

1963. Needle variation in loblolly pine from four geographic seed sources. Ecology 44: 168-169. SO

Trees representing dry portions of the species' range in Texas had fewer stomata, a thicker layer of epidermal cells, and more hypodermal cells than trees from southern Arkansas and northern Georgia. The Texas trees outgrew the others when planted on dry sites in north Mississippi.

Toole, E. R.

1966. Breeding for disease and insect resistance in hardwoods. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 20-24. SO

Brief review of methods, with examples.

———

1966. Early salvage necessary for hardwood tops. Miss. Farm Res. 29(5): 8. *Also as* Decay of hardwood logging slash. Miss. Agr. Exp. Sta. Inform. Sheet 932, 2 pp. SO

Bolts in tops of spring-cut trees should be salvaged almost immediately; those in fall-cut tops should be removed in winter or early spring. Cottonwood tops are a fire hazard for 3 years after logging, tops of other species for about 6 years.

Trousdell, K. B., Dorman, K. W., and Squillace, A. E.

1963. Inheritance of branch length in young loblolly pine progeny. U. S. Forest Serv. Res. Note SE-1, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C. SE

The ratio of crown width to tree height varied significantly between progeny of individual trees and between progeny of a group of wide-crowned trees and a group of slender-crowned trees. Height growth varied, also.

VanHaverbeke, D. F., and Barber, J. C.

1964. Seed crop estimation in a loblolly pine seed production area. Ga. Forest Res. Counc. Res. Pap. 21, 5 pp. SE

Application of binocular counts of cones to loblolly pine seed production areas. Sample counts were made on 100 standing trees and 50 were cut to get exact cone counts. Data are presented on the accuracy of the binocular counts and estimates derived for total seed production from the area. Collecting cones from trees producing a stated minimum of cones is important. By restricting collections to trees that have some minimum number of cones, such as 100 or 200, the majority of the seed can be obtained from the area with appreciable reduction in collection costs.

——— and Hunt, D. L.

1964. Some seed-cone-tree relationships in a loblolly pine seed production area. Ga. Forest Res. Counc. Res. Pap. 22, 5 pp. SE

The relationships of number of cones per tree, seed size, cone size, and various characteristics of the tree. Though several significant correlations are found, there are no strong relationships among the seed-cone-tree characteristics examined. The results strongly imply that the ability of the tree to produce cones is an inheritable characteristic.

Verrall, A. F.

1963. Control of diseases in southern forests. Soc. Amer. Forest. Proc. 1962: 138-139. SO

Development of resistant strains and manipulations of the forest environment to create conditions unfavorable to disease both hold great promise. Direct controls, as by spraying, will be of some use. Biological control seems unpromising.

Wakeley, P. C.

1963. How far can seed be moved? Seventh Southern Forest Tree Impr. Conf. Proc. 1963: 38-43. SO

Pending definitive results from provenance tests, the author hazards 10 recommendations concerning distances and directions that southern pine seed can be moved from source to planting site.

———

1963. Reducing the effects of nursery influences upon provenance tests. Forest Genet. Workshop Proc. 1962: 28-32. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm. SO.

Provenance tests should be designed to permit factoring out effects of variations in nursery environment, which may cause differences in survival and early growth of genetically identical stocks, or distort differences among genetically unlike stocks.

——— and Bercaw, T. E.

1965. Loblolly pine provenance test at age 35. J. Forest. 63: 168-174. SO

At Bogalusa, La., trees of Arkansas, Texas, Georgia, and local Louisiana origin varied significantly in six economically important characters, including rust resistance. Louisiana stock excelled at all ages, but the Texas stock, next best at age 22, was subsequently outgrown by Georgia stock—an indication that conclusions drawn from provenance tests at 10 or 20 years may be premature.

——— Wells, O. O., and Campbell, T. E.

1966. Mass production of shortleaf × slash pine hybrids by pollinating unbagged female flowers. *In* Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 78-79. North Central Forest Exp. Sta., St. Paul, Minn. SO

When slash pollen was dusted on the

unbagged strobili of 10 shortleaf pines, 10.7 percent of the resulting seedlings were hybrid.

Walkinshaw, C. H., Jewell, F. F., and Walker, N. M.

1965. Callus culture of fusiform rust-infected slash pine. U. S. Dep. Agr. Plant Dis. Reporter 49: 616-618. SO

C. fusiforme *was maintained in an apparently viable condition for 5 months. Indications are that it can be stimulated to grow in culture.*

Webb, C. D.

1963. Juvenile-mature tree relationships. Seventh Southern Forest Tree Impr. Conf. Proc. 1963: 55-58. SE

Selection for mature characteristics on the basis of juvenile performance cannot be as accurate as selections based on the mature tree. Yet, indications are that certain time-saving and essential information can be obtained from juvenile development. Resistance to certain diseases and insects and to drought can be evaluated during the juvenile stage. Other components of volume per acre, such as height, diameter, form class, and competitive ability will require a longer period of time. Traits such as straightness and wood specific gravity can be tested in young trees. Other traits of wood will require evaluation at 8 to 10 years of age or later.

1965. Variation in the wood of sweetgum. Forest Farmer 24(12): 9, 16-18. SE

A summary of a doctoral research project in which specific gravity, fiber length, and interlocked grain were investigated in 225 trees growing in the South Atlantic States. All three wood properties varied significantly within trees and among trees growing together in the same stand. The report makes the assumption that an appreciable part of the variation among trees is caused by hereditary differences that can be used in a breeding program, and advocates breeding sweetgum to improve form, bole quality, and growth rate as well as to increase fiber length and specific gravity but to reduce interlocked grain.

1966. Improvement of sweetgum. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 45-49. SE

Sweetgum, one of the most valuable southern hardwoods, has flowering, seeding, and planting characteristics that should facilitate the application of tree improvement to the species. Applied breeding offers a means of improving the growth efficiency of the species as well as the uniformity of the wood.

——— and Barber, J. C.

1966. Selection in slash pine brings marked improvement in diameter and height growth plus rust resistance. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 67-72. SE

Open-pollinated progeny tests at 5 and 8 years of age showed that selection produced substantial improvement in growth, resistance to fusiform rust, and volume per plot when compared with unimproved commercial check plots.

——— and Hunt, D. L.

1965. Seed crop estimation in a slash pine seed production area. Ga. Forest Res. Counc. Res. Pap. 28, 5 pp. SE

Demonstrates accuracy of cone crop estimates based on binocular counts and the relation between number of cones per tree and cost of seed per pound. Wide variation found in cone production per tree and number of seed per pound.

——— and Kraus, J. F.

1966. The status of progeny testing clones in the Georgia Forestry Commission seed orchards. Ga. Forest Res. Counc. Res. Pap. 36, 4 pp. SE

Progeny testing loblolly and slash pine seed orchards is well under way. Oldest plantations have completed five growing seasons, but all of controlled pollinations have not yet been completed. A total of 101 acres of progeny test have been set out, and an estimated 79 acres remain to be planted.

Wells, O. O.

1966. Variation in rust resistance among pine seed sources and species in a Mississippi planting. Forest Sci. 12: 461-463. SO

After 10 years there were significant differences in rust infection and height in a south Mississippi planting of Pinus elliottii, P. echinata, *and* P. taeda *from 11 seed sources. The slash pine was tallest and most infected; the shortleaf was shortest and had no rust cankers; and the loblolly was intermediate in both traits. Loblolly pines from seed collected west of the Mississippi River were more resistant to rust than eastern loblolly, and loblolly progenies from east Texas varied among themselves.*

——— and Wakeley, P. C.

1966. Geographic variation in survival, growth, and fusiform-rust infection of planted loblolly pine. Forest Sci. Monogr. 11, 40 pp. SO

Loblolly pines from 15 geographic seed sources, grown in 13 widely separated areas in the Southern United States, displayed well-defined patterns of variation after the first 10 years. In practically all plantings trees of western origin had survived best. In all but the coldest

locations trees from coastal areas had grown fastest. Trees from western sources and from the one source farthest to the northeast were consistently least infected by fusiform rust.

Wells, O. O., and Wakeley, P. C.
1966. The importance of seed sources. Forest Farmer 26(2): 8-11. SO
See entry above.

White, J. F., and Saucier, J. R.
1966. A comparison of the specific gravity of two slash pine varieties grown in south Florida. TAPPI 49: 230-232. SE
Eleven-year-old typical slash pine (Pinus elliottii *var.* elliottii) *produced a larger volume of wood of significantly greater density than South Florida slash pine* (P. elliottii *var.* densa) *of the same age grown on the same site.*

Wilcox, J. R.
1963. How can we improve southern hardwoods through genetics? Seventh Southern Forest Tree Impr. Conf. Proc. 1963: 31-34. SO
Genetic improvement appears possible in yellow-poplar, cottonwood, and the oaks. For other important hardwoods, data are lacking on variations and patterns of inheritance.

———
1966. Sweetgum seed quality and seedling height as related to collection date. Eighth Southern Forest Tree Impr. Conf. Proc. 1965: 121-123. SO
In south Mississippi, the seed can be safely collected for 6 or 8 weeks following October 1. If seed weight and rate of germinations are to be compared among lots, collections should be simultaneous.

———
1966. Vacuum storage of yellow-poplar pollen. In Joint Proc., Second Genet. Workshop of Soc. Amer. Forest. and Seventh Lake States Forest Tree Impr. Conf. U. S. Forest Serv. Res. Pap. NC-6, pp. 102-103. North Central Forest Exp. Sta., St. Paul, Minn. SO
Vacuum drying and storage at room temperature was not as effective as refrigerated storage but may be useful where long-distance transfer of pollen is anticipated.

——— Snyder, E. B., and Morrow, J. P.
1964. Modifications of the ampliscope for measuring hardwood fibers. J. Forest. 62: 581. SO
Simple optics formulas aid in constructing an ampliscope or increasing the magnification of an existing model.

Williston, H. L.
1962. Conifers for conversion planting in north Mississippi. U. S. Forest Serv. Tree Planters' Notes 54, pp. 5-7. SO
Loblolly pine appears best.

———
1963. Early yield of erosion-control plantations in north Mississippi. U. S. Forest Serv. Res. Note SO-1, 7 pp. Southern Forest Exp. Sta., New Orleans, La. SO
Survival of pulpwood-size pine plantations on eroded sites averaged 38 percent in loblolly, 48 in shortleaf, and 29 in slash. Annual growth per acre had been 0.89 cord for loblolly, 0.58 for shortleaf, and 0.88 for slash. Form class was 2 to 3 points better in loblolly than in shortleaf.

Zahner, Robert.
1962. Terminal growth and wood formation by juvenile loblolly pine under two soil moisture regimes. Forest Sci. 8: 345-352. SO
During 2 years of soil-moisture treatment in large containers, 5-year-old pines with ample moisture produced four internodes annually, as compared to two for trees not watered in summer. Gross radial growth was twice as great for wet as for dry trees, but net latewood band was equal. Wet trees continued to form earlywood well into summer, while dry ones began latewood formation in spring. Specific gravity of latewood was greater in dry trees than in wet; in earlywood there were no differences.

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Kraus, J. F.	Squillace, A. E.; Webb, C. D.
Krinard, R. M.	Johnson, R. L.
Langdon, O. G.	Bethune, J. E.
McAlpine, R. G.	Brown, C. L.; Steinbeck, Klaus
McGregor, W. H. D.	Allen, R. M.
McLemore, B. F.	Barnett, J. P.
McReynolds, R. D.	Burns, R. M.
Mallett, S. L.	Jewell, F. F.
Merkel, E. P.	Neunzig, H. H.
Morrow, J. P.	Wilcox, J. R.
Namkoong, Gene	Schmitt, Dan; Shelbourne, C. J. A.
Neelands, R. W.	Henry, B. W.
Olson, D. F., Jr.	Rodenbach, R. C.
Porterfield, E. J.	Kormanik, P. P.
Powers, H. R., Jr.	Gooding, G. V., Jr.
Rabb, R. L.	Neunzig, H. H.
Roncadori, R. W.	Snow, G. A.
Ruark, H. E.	McAlpine, R. G.
Saucier, J. R.	White, J. F.
Scarbrough, N. M.	Smith, L. F.
Silen, R. R.	Squillace, A. E.
Smith, H. D.	Smith, L. F.
Snyder, E. B.	Mergen, F.; Namkoong, Gene; Smith, L. F.; Wilcox, J. R.
Squillace, A. E.	Kraus, J. F.; Merkel, E. P.; Snyder, E. B.; Trousdell, K. B.
Stairs, G. R.	Mergen, F.
Steinbeck, Klaus	Kormanik, P. P.
Stonecypher, R. W.	Namkoong, Gene
Taras, M. A.	Saucier, J. R.
Wahlgren, H. E.	Christopher, J. F.
Wakeley, P. C.	Henry, B. W.; Wells, O. O.
Walker, N. M.	Jewell, F. F.; Walkinshaw, C. H.
Walkinshaw, C. H.	Kais, A. G.
Wells, O. O.	Switzer, G. L.; Wakeley, P. C.
Wilcox, J. R.	Farmer, R. E., Jr.
Wilson, D. R.	Stransky, J. J.
Yandle, D. O.	Merkel, E. P.
Zak, Bratislav	Bryan, W. C.
Zobel, B. J.	Cech, F. C.

Federal LAND BANK

FEDERAL LAND BANK TIMBER LOANS IN THE UNITED STATES

William C. Siegel

CLEMSON UNIVERSITY
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WOOD · WATER · FORAGE · WILDLIFE · RECREATION

SOUTHERN FOREST EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE
1967

The nine Federal land banks with timber-loan programs provided the basic information and data for this paper. Carroll K. Cardwell, Associate Chief of Appraisals, Land Bank Service, Farm Credit Administration, Washington, D. C., coordinated data collection, furnished guidance in interpreting the data, and reviewed the manuscript. Louis W. Eckstein, Jr., was largely responsible for compiling the tables.

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FEDERAL LAND BANK TIMBER LOANS IN THE UNITED STATES

Forest credit opportunities for America's woodland owners have increased rapidly in the postwar years. Timber financing is now available nationwide in one form or another. The most marked developments have taken place in the South and the Pacific Northwest, where timber growth rates and markets are generally more favorable than elsewhere.

Business experience shows that tree growing may be undertaken with expectation of a fair return on dollars invested. This fact, plus the prospect for increased forest product and stumpage prices, the scarcity of high-grade timber, rapid growth of certain valuable species, and industry's dependence on nonindustrial private woodlands as sources of raw material, have made forestry financially more attractive than in prewar years. And liquidity of forest properties in many areas has increased since 1950. Although the market at any particular time is difficult to forecast, timber holdings—especially in the South—usually have high sales values. As a result of all these conditions, private credit is now an increasingly important factor in forest development and operation in the United States.

There are three major sources of loans where timber is used as collateral—State and national banks, life insurance companies, and the Federal land banks of the Farm Credit System. National banks are authorized to accept timber as collateral under Public Law 285 as amended. This act permits unamortized 3-year loans on managed forests and 15-year amortized mortgages. Such provisions are more restrictive than those of the land banks. State banks not belonging to the Federal Reserve System are not subject to Public Law 285 and usually operate somewhat more freely under State law. Insurance companies, with their rather high loan minimums, generally do not provide credit to owners of small and medium-sized tracts. Thus the land banks are the chief source of long-term, small loans on timber and timberland.

This paper first reviews the development and present operation of the Farm Credit System. Special attention is given to its facilities for making favorable loans to woodland owners. Next, the forest credit program of the Federal land bank in each of the 12 farm credit districts is described, and loan and borrower characteristics for each bank are discussed and compared. Finally, the potentialities and opportunities for improving forest management through land bank credit are analyzed.

THE FARM CREDIT SYSTEM

In the early part of the twentieth century demand became widespread for a national rural credit system. Farmers then did not have the credit advantages enjoyed by industries in large population centers. There was an urgent need for long-term farm mortgage loans at low interest.

As a result, the Federal Farm Loan Act was enacted on July 17, 1916. It authorized the establishment of 12 district Federal land banks and the organization by farmers of numerous local Federal land bank associations (called national farm loan associations before 1960). A basis for long-term credit to individual farmers through local cooperatives was thus established. The legislation further provided for agricultural development capital, standard forms of investment based on farm mortgages, and equalization of interest rates on farm loans.

The act also stipulated that the banks and associations would be supervised by the Federal Farm Loan Bureau of the U. S. Treasury Department. This Bureau was superseded in

1933 by the Farm Credit Administration, now an independent agency of the executive branch of the Federal Government.

Despite popular misconceptions, neither the land banks nor the land bank associations are Government-owned. The capital stock of the 12 banks is held entirely by the land bank associations. Each association is a corporation, federally chartered by the Farm Credit Administration and under the general supervision of the Administration's Director of Land Bank Services. At the local level, an association operates under the control of a board of directors elected by and from its membership. Each member is entitled to one vote only, regardless of the number of shares of stock he owns.

A land bank borrower buys stock in his local association in the amount of 5 percent of his loan, and thus becomes a member-owner of the association. The stock usually pays dividends, and its cost may be included in the loan. The association in turn buys the same amount of stock in the Federal land bank. Stock is held by the bank and the association, respectively, as additional security for the loan, and is usually retired at par when the loan is paid in full.

Some of the misconceptions concerning the Federal Government's role with the land banks arose when the Government supplied the initial capital for the banks—a total of $9 million. This was almost all repaid within a few years, but in the depression of the 1930's Congress assigned the land banks the task of refinancing the Nation's huge agricultural debt. To facilitate progress, Government funds were again placed in each of the 12 banks. In 1947, the last of the Government capital was repaid in full, and the banks became completely member-owned.

The Federal Farm Loan Act defines the functions of the land banks and limits their lending authority. Loans must be based on the normal value of the collateral offered as security. The "normal" concept was adopted in 1933, when credit based on the current market values of farms was inadequate. Consideration was thus given, and still is, to long-term averages of net returns and land values in particular areas. Expected returns from shifts in crop alternatives are also recognized.

Other banks and associations were established in the Farm Credit System in subsequent years, primarily to extend short-term credit. Twelve district Federal intermediate credit banks were created in 1923 by the Agricultural Credit Act of that year. Their original task was to rediscount agricultural loans for existing commercial lending agencies, particularly agricultural credit corporations. These banks are in the same cities as the 12 Federal land banks and are governed by the same boards of directors. They are also supervised by the Farm Credit Administration.

In 1933 the system of Production Credit Associations was formed. These local cooperative organizations extend short- and intermediate-term credit to farmers and farming corporations for any agricultural purpose, including timber operations. The intermediate-term loans mature in 2 to 7 years. The associations obtain their funds by discounting loans with the intermediate credit banks.

When the Federal intermediate credit banks began operation in 1923, all of their stock was owned by the Government. But in 1956 legislation was enacted to authorize the production credit associations to become stockholders of the banks. At present the intermediate credit banks are partly owned by the associations, and it is planned that the Government capital will be retired. Ultimately the capital stock of the credit banks will be entirely owned by the associations.

Thirteen banks for cooperatives—12 district banks and the central bank in Washington, D. C.—were established in 1933 to provide a permanent source of credit for farmers' cooperative associations. The district banks are in the same cities, have the same boards of directors, and serve the same territories as the Federal land banks. Credit of three types is extended: loans secured by approved commodities, seasonal or short-term loans to supplement borrowers' working capital, and term loans to finance facilities or general operations.

The banks for cooperatives are largely owned by stockholders of farm cooperative associations. As cooperatives borrow from a bank, they purchase capital stock in the bank in proportion to the interest paid on their loans. Since the banks themselves are cooperatives, their net earnings are distributed to borrowers as patronage refunds. In this manner cooperatives are continually acquiring additional stock in the banks, and the initial capital investment by the Government is gradually being retired.

By 1971, all the banks for cooperatives are expected to be entirely owned by the farmer cooperatives they serve.

To be eligible to borrow, a cooperative must do at least as much business with members as with nonmembers; and voting control must be held by farmers (including tree farmers) or cooperatives controlled by them. Before 1959 the banks for cooperatives could only make timber loans to those cooperatives handling timber or timber products grown or manufactured by farmers as part of general farming operations. In that year the regulations were changed to include cooperatives serving tree farmers.

The Farm Credit System took essentially its present form when it was placed under the supervision of the Farm Credit Administration in 1933, after the banks for cooperatives and production credit associations were created. The Farm Credit Administration has served since then as the overall supervisory and policy-making body for the system. It is supported financially by assessments against the district banks.

Lending funds of the Farm Credit System come from four sources—capital stock purchases, retained earnings of local associations and district banks, sale of bonds and debentures on the open money market, and Government capital remaining in some units of the system. The bonds and debentures are regarded in the market as prime paper, comparable to Government and other high-grade bonds. They are not Government bonds, however, nor is payment guaranteed by the Government.

LAND BANK LOAN PROGRAMS

Federal land bank timber loans in the aggregate are big business today, and the programs are rapidly expanding. As of October 1, 1966, forest credit was extended by the Federal land banks in nine of the 12 farm credit districts (fig. 1). Those without formal woodland lending programs are the St. Paul, Omaha, and Wichita banks in districts 7, 8, and 9 respectively. Thus the only States where land bank timber loans are not readily available are Michigan, Wisconsin, Minnesota, North Dakota, Iowa, South Dakota, Nebraska, Wyoming, Kansas, Colorado, and New Mexico.

Loan applications are made through the association responsible for the area in which the timber collateral is located. Each association has a resident manager and is chartered to serve a specific territory—usually several counties. The number of associations per State varies widely. For instance, there are seven in Florida but 31 in Illinois.

The 12 land banks obtain loan funds by collectively selling their bonds on the open market. These securities then become the joint obligation of all the banks. When a loan is made by a bank, the association involved endorses the note and sends it to the bank to secure the loan. The association-endorsed notes are security for the bonds issued by the banks.

Forest credit history.—The land banks of Columbia, South Carolina, and New Orleans, Louisiana, were the first to develop a basis for using timber as collateral. In 1944 both made the first loans in which timber and forest land provided the sole security. Previously they had accepted woodland acreage but not timber, and had also required the inclusion of crop and pasture land as part of the collateral. After a slow start the two have built up a multimillion dollar timber loan business.

The Federal Land Bank of Columbia extends forest credit through 15 associations in North Carolina, nine in South Carolina, 15 in Georgia, and seven in Florida. The New Orleans bank operates through 19 associations in Alabama, 17 in Louisiana, and 21 in Mississippi. Both banks have staffs of professionally trained foresters and have been leaders in promoting good forestry through sound credit programs.

Table 1 indicates the progress made in forest lending by the New Orleans and Columbia banks during the 10-year period 1954 to 1964. Loans tabulated include all those with timber and timberland as a substantial portion of the collateral and also those where income from the timber collateral is needed to meet the payments. Although the loans by both banks have steadily increased in size, those of the New Orleans bank have averaged considerably larger than those of the Columbia bank. The latter, however, continues to have the largest number of loans and amount outstanding.

The Federal Land Bank of Houston, which serves the State of Texas, began its formal timber lending program in late 1957. Timber loans on an individual, isolated basis, however,

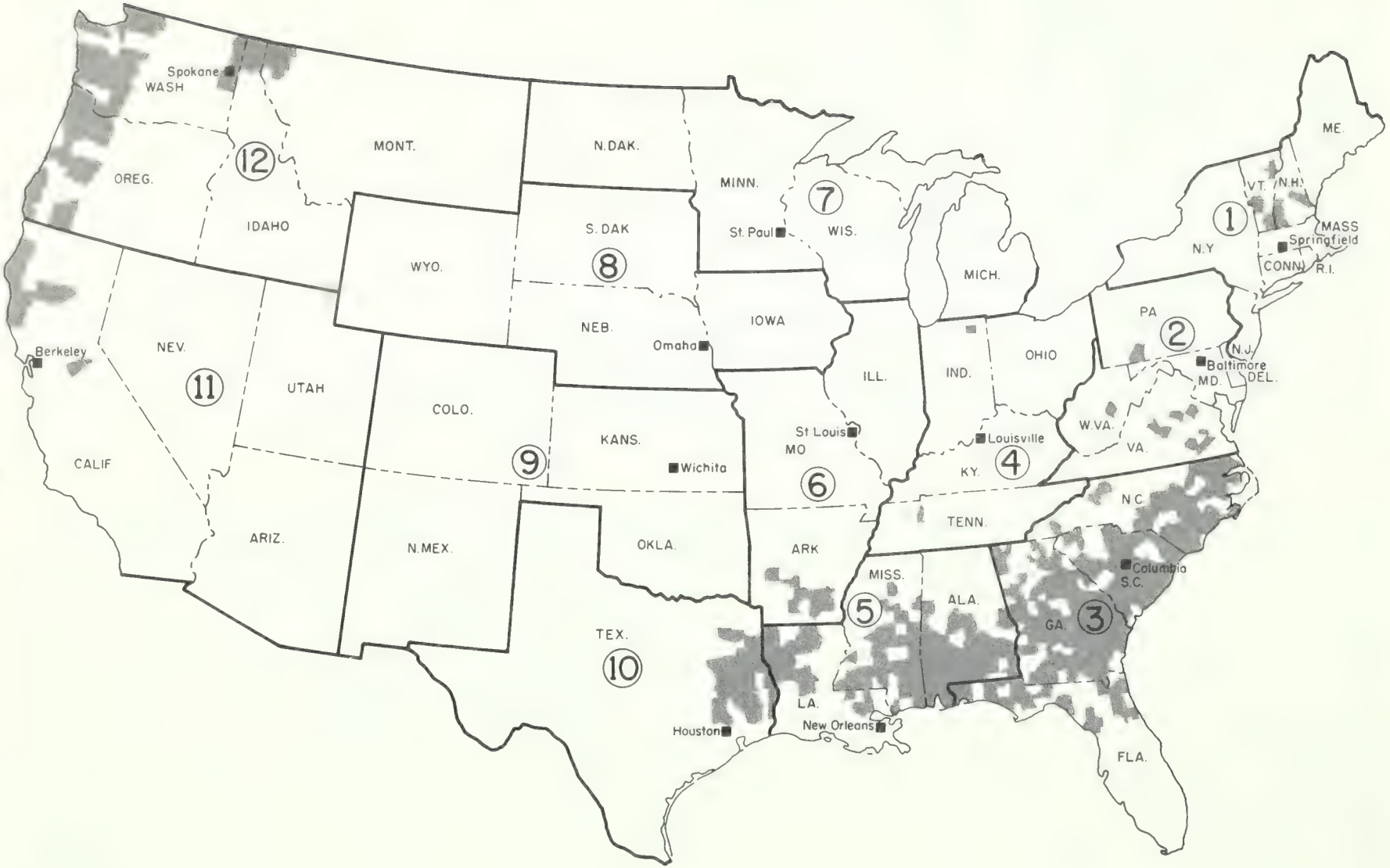

Figure 1.—*Farm credit districts of the Farm Credit System. Shaded areas represent counties with forest collateral in October 1966.*

Table 1.—*Number and unmatured principal of active timber loans in the New Orleans and Columbia districts on selected dates*

Date	New Orleans district			Columbia district		
	Loans outstanding	Total amount outstanding	Average amount outstanding, per loan	Loans outstanding	Total amount outstanding	Average amount outstanding, per loan
	Number	*Dollars*	*Dollars*	*Number*	*Dollars*	*Dollars*
1954	38	403,230	10,611	615	3,193,414	5,193
1955	69	923,726	13,387	741	4,100,439	5,534
1956	107	2,087,956	19,513	776	5,384,889	6,939
1960	275	6,009,622	21,853	1,106	12,262,935	11,088
1964	304	10,100,000	33,224	1,111	18,862,032	16,978

were let as early as 1955. The bank's forest credit is granted through the five associations serving the timbered area of east Texas. At first most of the loans with timber as collateral also involved—but did not require—some farmland or pastureland or both. In recent years, more loans have been made on entirely forested tracts. The Houston bank employs no foresters, since it feels that the timber phase of its lending operations is not yet large enough. Borrowers engage independent foresters for cruising prospective collateral.

The next banks to initiate forest loan policies were those in Spokane and Baltimore. Both began their formal programs in 1960, although the Baltimore bank made a few timber loans as early as 1954. The Spokane bank serves 16 associations in Washington, 13 in Oregon, 13 in Idaho, and 19 in Montana. Its personnel made an extensive study of the problem for 2 years, in cooperation with public and private forestry agencies, before adopting a timber loan policy. The Federal Land Banks of Columbia and New Orleans were also consulted. Initially loans were made only on coniferous timber in the Douglas-fir region west of the Cascades in Oregon and Washington. With the accumulation of experience in this region, however, the program was later extended to coniferous woodlands east of the Cascades. In the early stages, the Spokane bank generally confined its forest loans to tracts where a substantial part of the overall value and earning power was from open land devoted to livestock or farm crops. As experience accumulated, loans were made on all-forested tracts. The bank employs a staff of foresters.

The Baltimore bank extends credit through 11 associations in Pennsylvania, 13 in Virginia, four in West Virginia, one in Delaware, and five in Maryland. Primary emphasis is on tracts in the softwood areas of the district. Having no foresters on its staff, the bank relies on consultants for cruises and appraisals.

The St. Louis Federal Land Bank actively entered the timber loan business in 1963. It serves 65 associations—23 in Missouri, 11 in Arkansas, and 31 in Illinois. Lending at the present time is limited to pine tracts—no hardwood loans are made. All of the loans have been in the commercial timber areas of Arkansas, where two associations each employ a forester. The foresters' duties consist primarily of promoting business and servicing loans. Cruises of collateral tracts are made by consulting foresters.

The Springfield and Berkeley banks both began making forest loans in 1964. The Springfield bank, in revising its formerly restrictive policy, was influenced by a 1961 change in the law which permits partially amortized and nonamortized loans. Nevertheless, its program is small and it anticipates little future demand in the eight States served—New York, New Jersey, Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine. The bank employs no foresters.

The Berkeley bank's efforts have been primarily directed to the forested areas of central and northern California—particularly to the redwood belt—although it also serves the States of Arizona, Utah, and Nevada. It has one professional forester for loan promotion, appraisals, and related duties.

The Louisville land bank began its woodland lending program in 1966, after adopting a forest loan policy in 1965. For some years prior to that time, however, it had recognized timber values in making loans on farmlands. The Louisville district has 14 associations in Kentucky, 17 in Tennessee, 21 in Ohio, and 26 in

Indiana. Timber loans were considered as early as 1952, but it was not felt that forest protection programs were then adequate. The bank staff includes no foresters. Consultants are retained for loan appraisals.

Though the St. Paul, Wichita, and Omaha banks all have privately owned, commercial timber acreage in their districts, they have no formal timber loan programs. The St. Paul district, after a recent feasibility investigation, decided that a formal program was not justified. Following a similar study, the Wichita district has decided to make loans in eastern Oklahoma. In all three districts, however, woodland values have previously been included in a number of farm loans, and the policy has been to consider timber loans on an individual basis.

Eligibility of applicants.—Individuals, partnerships, and many farming or timber-growing corporations are eligible for land bank timber loans, provided they presently own and manage forest acreage or shortly expect to do so. Before June 3, 1935, no corporations of any kind could apply for a loan. On that date livestock corporations only became eligible.

Corporations that are primarily engaged in farming or timber growing have been fully eligible since January 1, 1956—before then they could obtain loans only by acting as a representative or fiduciary for an individual. The 1956 amendment to the law specified that the owners of at least 75 percent of the corporation's value and of at least 75 percent of the number of shares had to be actually engaged in farming, and that at least 75 percent of each category of owners had to endorse and be liable for the note. On October 3, 1961, the law was further amended and made more liberal. The requirement since then has been that at least 51 percent of the corporation's income must be derived from farming, including timber operations, and that one or more individuals owning a substantial portion of the corporate stock must endorse the note.

Although each land bank has its individual loan policy, certain broad requirements are common to all. Successful applicants must meet normal credit prerequisites for a sound bank loan, be financially solvent, and have substantial equity in the property offered as security. They are also expected to have some experience in managing timberland, including protection against hazards and operation for optimum returns.

Loan size and security requirements.—Before January 1, 1960, land bank loans were limited by law to a maximum of $200,000. On that date the maximum became flexible, differing with each bank and based on the System's capital structure. Now the most that a particular bank can lend an applicant at any given time is equal to the larger of two amounts: (1) 10 percent of the present capital net worth of the lending bank, or (2) 10 percent of one-twelfth of the present capital net worth of all 12 banks. Loans exceeding $5 million can be written in all of the farm credit districts.

The nine land banks making timber loans all have similar requirements regarding collateral. The acreage must be an economic unit and readily salable in normal times. Except in the New Orleans and Columbia banks, loans are made only on tracts with substantial amounts of merchantable timber.

For a number of years the two southern banks have sometimes accepted as collateral excellent stands of very nearly merchantable young timber. In 1967 the two opened a new dimension in timber financing by beginning to accept applications for loans on young pine stands as far as 5 years from merchantability. Plantations on bare land, planted pines on property already partially wooded, and naturally seeded tracts are all acceptable security under the new policy.

A number of factors are looked at in evaluating loan applications on young planted pines. On good sites, plantations 5 to 7 years old are generally considered to be within 5 years of merchantability. Local utilization and marketing practices determine the point of merchantability. The beginning of the 5-year period is determined by evaluating tree species, as well as brush conditions, soil quality, moisture conditions, and other site factors affecting the rate of growth. Tree vigor, overall stand condition, accessibility, market conditions, alternative land uses, and existing protective measures are also considered.

All nine banks require that tracts offered as collateral be self-supporting. Prospective timber growth and harvest during the term of the loan must be sufficient to provide

enough income to pay all operating costs, fixed charges, and loan installments. Each bank requires a working management plan. While the plan need not be written, it must provide for protection and for sufficient sustained production to insure orderly retirement of the loan. The banks do not require the borrowers to make annual or periodic cuts if other income is available for payments and the timber will not depreciate from postponed harvesting.

Loans are made by the banks only in areas where timber markets are well established and there is evidence that sustained production can be profitable. The St. Louis, Columbia, Spokane, and Berkeley banks specifically limit lending to coniferous stands but assign a value to merchantable hardwoods in such stands. The Louisville, New Orleans, and Springfield banks, on the other hand, lend on both coniferous and hardwood timber. The Houston bank has received no requests for hardwood loans but would consider applications if submitted.

Loan contract provisions.—A first mortgage is required by law on any property offered as collateral for a land bank loan. This provision does not necessarily prohibit a second mortgage being held by another party at the time a loan is closed or subsequent thereto. The basic note connot exceed 65 percent of the appraised normal agricultural value of the collateral, or a lesser proportion if recommended by the association handling the application. Borrowers from all the banks are required to purchase their association's stock to the value of 5 percent of the total loan. This amount may be added to the note if desired. Thus the maximum total that may be borrowed is 68.4 percent of the security's appraised normal value.

Interest rates charged by the banks vary with the condition of the money market but are the same for timber loans as for other types of notes. At times the rate has been as low as 4 percent. Under the Federal Farm Loan Act, 6 percent is the maximum. In 1967 all banks were charging 6 percent.

Repayment plans at each of the nine banks that extend forest credit can be adapted to cutting cycles and are generally arranged to meet the borrower's individual needs. The majority of timber notes are amortized under one of two plans—Standard or Springfield—depending on the nature of the security. The former, sometimes called the "even payment" plan, results in equal annual installments and a slower rate of principal reduction. It is used with woodland collateral that is expected to maintain a sustained earning level over the period of the loan. The Springfield plan is sometimes called the "decreasing payment" plan. It calls for equal annual principal payments plus interest on the unpaid balance, and thus reduces the principal much faster in the early years of the loan than does the Standard plan. It was designed for properties from which earnings may not be sustained throughout the loan term. Eight of the nine banks use both plans; the Houston bank has adopted the Standard plan exclusively. Amortized loans under either plan may run from 5 to 40 years.

The partially amortized loans authorized under the 1961 amendment may be for terms of 5 to 40 years. In years when timber cutting is not desirable they obligate borrowers only for interest and perhaps token principal payments. Under the same amendment, unamortized loans permit the principal payment to be made at the end of the loan term, which may be up to 10 years. This arrangement is designed for timber stands too light or too young for frequent cutting. Exact provisions depend on production possibilities and the value and durability of the security.

At present there are no active unamortized timber loans in the land bank system. And only three banks—Columbia, New Orleans, and Baltimore—have active partially amortized notes. The Houston district will not consider applications for either type, whereas Louisville and St. Louis report they would write both variations if the opportunity arose. The New Orleans bank is also willing to grant unamortized loans. The Berkeley, Spokane, and Springfield districts have not stated their policies concerning either type, nor has the Baltimore district expressed itself in regard to unamortized notes.

All the banks allow advance payments to be made at any time without penalty. These may be used to reduce the principal or may be allocated to a "future payment" fund. Borrowers are paid interest on their money in these funds, and the balance can be drawn on at any time to meet a loan payment. The rules regarding advance payments vary among districts. For instance, the Columbia bank allows

up to three loan installments to be paid into the fund. Interest rates paid borrowers also vary, ranging from 4 percent in some districts to the rate being charged for the loan in others. Most of the banks report that only a small proportion of those with timber loans pay into the funds.

Applications, fees, and appraisal procedures.—Applications for timber loans in all districts are made through the association serving the county where the collateral is located. The Houston, St. Louis, Louisville, and Spokane banks have no application fees. The Baltimore fee varies among the associations. The New Orleans bank requires a $10 payment with applications up to $1,000 and $15 for larger requests. The Columbia fee is $10 per application regardless of amount. Some associations in some districts charge a nominal loan closing fee.

All of the banks require an appraisal of the timber collateral. This usually involves an inventory or cruise of the merchantable stems by species, timber type, and diameter class. Information is also taken on the volume of young stock and its estimated annual growth. These data have a direct effect on tract valuation. If the stand is in naval stores production, number and size of trees with and without working faces, and stages of working, are also recorded.

Cruises in the Columbia, New Orleans, and Spokane districts are carried out by bank appraisers—usually graduate foresters with local experience. These appraisers offer no technical advice or assistance to landowners but merely evaluate the timber. For stands exceeding 200 acres in size, the Columbia bank charges an appraisal fee of 10 cents per acre. If the cruise cost turns out to be less than this, the difference is refunded. No charge is made for appraising smaller tracts. The New Orleans cruise fee is 5 cents per acre on that portion of the timberland in excess of 300 acres, but the total may not exceed $600. The Spokane charge is $35 for the first 40 acres and 50 cents for each additional acre of timber in the specified eligible diameter classes. If a forest inventory and stand map prepared by a qualified professional or consultant forester is submitted with an application to one of these banks, the appraisal may be greatly expedited and the cost reduced.

The Houston bank requires a cruise by an accredited forester at the borrower's expense when the proposed security consists of more than 100 acres of merchantable timber. If there is less than 100 acres of woodland, the cruise is made jointly by a bank appraiser and the association manager, without a fee. The Baltimore bank requires a detailed cruise by a consultant forester at the owner's expense when the normal value of the timber is 20 percent or more of the total normal value of the collateral. The St. Louis and Louisville districts both require cruises by consultant foresters at the expense of the applicant. Appraisals in the Berkeley district are made by either staff or consulting foresters, at the applicant's expense.

To determine a tract's loan value, all the banks apply a schedule of "normal" stumpage prices to the cruise data. These prices represent estimates of long-term market levels and are readjusted periodically in light of changing conditions. Additional factors considered in the appraisal include the risk of fire and other hazards, the way the stand has been managed in the past, and the feasibility of sustained production. The soundness of the owner's management and cutting plan is also evaluated.

Supervision and cutting of timber.—Eight of the nine banks require annual inspections of all timber properties that constitute major collateral. The primary purposes are to determine whether there has been any damage from fire, insects, or other causes, and if there has been any unauthorized removal of timber. The Baltimore bank requires inspections every 2 years but plans to go to an annual basis in the near future. Inspections in all districts are made by the local associations with the assistance of appraisers when needed.

Timber cutting procedures on collateral properties differ among districts. Some of the banks limit the amount of cutting the borrower can do without further permission from the bank. In other districts, an application is required for each proposed cutting. All banks require cutting reports after logging has been completed. In most districts the local association managers are authorized to process and approve release applications when there have been no adverse changes in the property and the proposed cut does not exceed the accumulated annual growth. Usually the species, sizes,

and volume of timber to be harvested, and the tracts from which it will come, must be indicated in the application. Some banks charge a fee for filing a release application. The Spokane bank, for instance, charges $30 for the first 40 acres plus 25 cents for each additional acre affected by the cut.

The usual procedure is to require a payment on the principal of the loan proportionate to the "normal" value of the timber cut. In some districts, however, the borrower may use all or part of the proceeds for other purposes. The approval is contingent upon the loan being current and the residual security adequate to cover the unpaid balance.

THE LOANS AND THE COLLATERAL

Number of loans rapidly increasing.—On October 1, 1966, there were 980 active timber loans in the Federal land bank system. The total face value was nearly $45 million and the outstanding balance about $39.5 million. For the purposes of this study, a timber loan was defined as one for which timber and timberland account for more than half of the normal value of the collateral. Before 1960 lending experience under these criteria was somewhat sparse—only 87 of the existing loans were made then. More than a third of the current notes were written in 1965 and 1966.

Many active contracts with timber as security did not meet the study's definition of a timber loan. A large number of these were made before 1960. The amount of such lending —i.e., on woodland that constitutes only a minor portion of the total collateral—is substantial. At the end of 1966 the value of the woodland portion of these loans amounted to about $76 million (table 2). In addition, a large number of timber notes have been retired since the various lending programs began. The discussion hereafter will exclude both these categories and refer only to the 980 current loans that meet the given criteria.

Loan refusals and foreclosures are few.—All nine banks actively encourage timber loan applications. Generally, rejections have been fewer than when cultivated land has been offered as collateral. As experience with woodland lending has grown, few applications have been accepted without prior indications that the security offered would meet the banks' requirements. The primary reasons for the rejections that have occurred are the owners' lack of equity, sustained earning capacity, knowledge of practical operating procedures, or financial responsibility. The banks report that there has never been a foreclosure on a timber loan, although there have been some on notes that had timber as minor collateral.

Table 2.—*Loan volume secured by woodland that constitutes a minor portion of total collateral, October 1966*

Land bank	Loan volume
	– *Dollars* –
Springfield	0
Louisville	0
St. Louis	28,000
Berkeley	67,000
Houston	250,000
Baltimore	250,000
Spokane	475,000
New Orleans	4,810,664
Columbia	70,000,000
Total	75,880,664

Lending concentrated in South and Northwest.—Most of the current loans—over 90 percent of the total—are in the Southern States. The bulk of the remainder are in the Pacific Northwest. The counties where woodland collateral is located are shaded in figure 1. More than two-thirds of the southern loans were in the four southeastern States comprising district 3. Nearly 40 percent of the total contracts were in Georgia alone.

In North and South Carolina timber loans are concentrated in the Coastal Plain. Woodland ownerships in this region are considerably larger and more stable than in the Piedmont and mountains, where there are large areas of low-grade hardwood. And, too, the pine in the western parts of these States is often of lower value than that in the Coastal Plain.

Most Georgia loans have been made in the southern two-thirds of the State. In the mountainous areas of the north much of the forest is in poor condition and suitable collateral is scarce. Florida contracts are grouped in the northeastern and northwestern corners of the State. The north-central region also contains an abundance of good pineland, but much of it is in large ownerships or soil bank plantations, or is used primarily for cattle raising.

Almost one-fourth of the loans were made in the three Midsouth States of district 5, and over half of these were in Alabama. In Alabama and Mississippi, contracts are concentrated in the southern two-thirds of each State; in Louisiana they are centered in the northwest and in the Florida parishes of the southeast. These areas account for most of the district's pine production. No loans have been written on hardwood tracts in the bottom lands along the Mississippi River.

In a large part of northern Mississippi soil erosion is severe and woodlands are depleted. In northern Alabama a sizable portion of the timberland is hilly and in poor condition. Southern Louisiana is largely cutover cypress land, and the central part contains a large acreage of national forest. Thus eligible collateral in these areas is somewhat limited.

Texas loans are concentrated in the east-central part of the State—none of the current loans are in the southeast or northeast, where stands and sites are generally poorer. All Arkansas collateral is in the State's south-central loblolly region—there are no current contracts in the shortleaf province to the north. Most west coast lending has been in the coastal Douglas-fir and redwood areas west of the Cascades and Sierras, where timber development has been most advanced. Recently a few loans have been made in the pine regions east of the mountains, where sites are somewhat poorer and less capital has been invested in the timber economy.

Loan sizes and tract acreages vary by year of loan.—The number of timber loans is rapidly increasing. But there is no discernible pattern in either loan size or collateral acreage by year of loan (table 3). The active contracts made in 1965 average largest in value—about $65,000. Average woodland collateral is highest for 1957 notes. Loans made in 1955 are a close second in both value and acreage. Contracts written in 1966 average about 50 percent less in face value and acreage than those let in 1965. In October 1966 the smallest and largest active loans were for $600 and $2,250,000. The smallest and largest timber tracts secured were 20 and 45,532 acres.

Most loans are for maximum amount.—The majority of timber loans are made for the maximum allowable percentage of normal tract value (table 4). Only 14 percent of the 980 active loans in October 1966 were for less than 50 percent of collateral appraisal. The pattern, however, varies among and within districts.

In district 3, South Carolina landowners borrow to the maximum more often than those in North Carolina, Georgia, or Florida. In district 5, a much higher proportion of Alabama and Louisiana loans are for the maximum amount than are Mississippi notes. In district 12, Oregon borrowers apply for the allowable limit to a much greater extent than do Wash-

Table 3.—*Number, face value, and forest acreage collateral of loans outstanding in October 1966, by year of loan*

Year	Loans			Forest acreage collateral	
	Number	Total value	Average value	Total	Average
		Dollars	*Dollars*	*Acres*	*Acres*
1953	1	600	600	86	86
1954	1	20,150	20,150	341	341
1955	6	374,950	62,492	11,675	1,946
1956	9	315,900	35,100	12,599	1,400
1957	9	521,420	57,936	21,470	2,386
1958	24	545,658	22,736	15,117	630
1959	37	1,129,451	30,526	31,271	845
1960	60	2,572,084	42,868	60,850	1,014
1961	86	3,696,086	42,978	79,472	924
1962	119	5,716,400	48,037	128,378	1,079
1963	132	6,127,145	46,418	168,523	1,277
1964	131	5,591,940	42,687	98,712	754
1965	193	12,448,947	64,502	260,203	1,348
1966	171	5,835,920	34,128	109,148	638
All years	[1] 980	44,991,651	45,910	997,895	1,018

[1] Includes one loan for which no year was reported.

Table 4.—*Proportion of appraised tract value loaned in notes current in October 1966*

District and State	Percent of normal tract value													
	0-9		10-19		20-29		30-39		40-49		50-59		60-65	
	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
District 1														
Vermont													2	100
New Hampshire													1	100
District													3	100
District 2														
Pennsylvania													1	100
Virginia							1	10					9	90
West Virginia											1	50	1	50
District							1	8			1	8	11	84
District 3														
North Carolina			1	1	1	1	7	7	8	8	14	13	73	70
South Carolina			1	1			4	4	10	11	6	6	74	78
Georgia			3	1	6	2	18	5	25	7	65	17	256	69
Florida					1	3	1	3	2	5	6	16	27	73
District			5	1	8	1	30	5	45	7	91	15	430	71
District 4														
Tennessee													1	100
Indiana													1	100
District													2	100
District 5														
Alabama					3	3	6	5	6	5	16	13	90	74
Mississippi							4	5	2	3	21	29	46	63
Louisiana			1	3			3	9	1	3	3	9	26	76
District			1	1	3	1	13	6	9	4	40	17	162	71
District 6														
Arkansas					1	11	1	11			1	11	6	67
District 10														
Texas	1	2	1	2	1	2	2	4	1	2	2	4	41	84
District 11														
California			1	11	1	11					1	11	6	67
District 12														
Oregon					1	3	1	3	2	7	3	11	22	76
Washington							2	7	6	21	3	10	18	62
District					1	2	3	5	8	14	6	10	40	69
United States	1		8	1	15	2	50	5	63	6	142	14	701	72

ington applicants. In both Texas and Virginia, the proportion of loans written for the maximum loanable is considerably above the national average.

It appears that an increasing proportion of lending is being done on properties with a greater volume of timber per acre than in former years. In general, these newer loans also constitute a larger percentage of property value than did those of the past. Higher appraisals in recent years have contributed to the increase in amounts loaned per acre.

Most tracts only partly forested.—Only about 21 percent of the active loans in October 1966 were on tracts entirely stocked with timber. More than seven out of 10, however, were on land more than 70 percent forested. A small number had collateral acreage which was less than one-third woodland but on which the timbered portion had a value much greater than the open. Most of these loans were on Oregon and Washington tracts with valuable Douglas-fir stands.

Interdistrict differences are apparent. In the southeastern States of district 3, only 14 percent of the notes were on entirely forested acreage. The corresponding proportion was 36 for the Midsouth States of district 5. The percentage was particularly high in Alabama and Louisiana, and also in Texas which comprises

district 10. The proportion of all-forested tracts was lowest in the Pacific Northwest States of district 12. There only two loans out of a total of 58 are on such collateral.

Loan sizes and tract acreages vary by State and property type.—Timber loans written in the districts with the newest programs are generally much larger in amount than older contracts. The Columbia bank (district 3) had nearly two-thirds of all active loans in October 1966, but the face value was only slightly more than half of the total. Columbia notes averaged $39,289, a value that was exceeded in six of the other eight districts (table 5). Only the 51 loans in districts 4 and 10 averaged less. District 11 contracts—all in California—were largest, averaging over $300,000. California loans comprised less than 1 percent of the total number but nearly 7 percent of the total value.

Size differences are also apparent within districts. In district 3, North and South Carolina loans average considerably higher than those written in Georgia. And the average Florida note is about four times that in North and South Carolina and five times that in Georgia. In district 5, Alabama loans comprise

Table 5.—*Number, face value, and forest acreage collateral of active loans, October 1966*

District and State	Loans			Forest acreage collateral	
	Number	Total value	Average value	Total	Average
		Dollars		*Acres*	
District 1					
Vermont	2	97,000	48,500	7,591	3,796
New Hampshire	1	43,000	43,000	3,934	3,934
District	3	140,000	46,667	11,575	3,842
District 2					
Pennsylvania	1	82,000	82,000	1,000	1,000
Virginia	10	587,100	58,710	17,571	1,757
West Virginia	2	175,000	87,500	8,349	4,175
District	13	844,100	64,931	26,920	2,071
District 3					
North Carolina	104	3,629,407	34,898	83,699	805
South Carolina	95	3,569,778	37,577	66,752	703
Georgia	373	11,179,223	29,971	264,095	708
Florida	37	5,548,400	149,957	128,564	3,475
District	609	23,926,808	39,289	543,110	892
District 4					
Tennessee	1	22,000	22,000	309	309
Indiana	1	40,000	40,000	110	110
District	2	62,000	31,000	419	209
District 5					
Alabama	121	8,473,547	70,029	186,807	1,544
Mississippi	73	2,412,923	33,054	52,305	717
Louisiana	34	1,104,318	32,480	17,311	509
District	228	11,990,788	52,622	256,423	1,125
District 6					
Arkansas	9	606,155	67,351	22,728	2,525
District 10					
Texas	49	1,652,900	33,733	45,781	934
District 11					
California	9	2,930,700	325,633	63,962	7,107
District 12					
Oregon	29	675,200	23,282	3,110	107
Washington	29	2,163,000	74,586	23,917	825
District	58	2,838,200	48,934	27,027	466
United States	980	44,991,651	45,910	997,895	1,018

little more than half of those made but their face value is about 70 percent of the total. The average Alabama contract is more than double that in Mississippi and Louisiana. Half of the loans in district 12 were in Oregon and half in Washington, but the average Oregon note was for less than one-third that in Washington.

The forest acreage securing the average loan varies widely among States and districts (table 5). It is highest in California at 7,107 acres. West Virginia, New Hampshire, Vermont, and Florida follow in order—all have more than 3,000 acres. The average woodland tract in the remaining States is less than 3,000 acres, and is lowest in Oregon at 107. The districts with the most loans and the oldest lending programs generally have the least timberland collateral per note.

Loans on properties that are completely forested generally average considerably higher in amount than those on partly forested lands (table 6). The only exceptions were in Arkansas, Texas, South Carolina, Louisiana, Oregon, and Washington. And in the two last-named States only two of the 58 contracts were on all-forested tracts.

In district 3, loans on all-forested properties averaged more than double the amount of

Table 6.—*Loan values by tract type, October 1966*

District and State	Tracts entirely forested			Tracts partly forested		
	Aggregate face value of loans	Proportion of total value	Average face value of loans	Aggregate face value of loans	Proportion of total value	Average face value of loans
	Dollars	*Percent*	*Dollars*	*Dollars*	*Percent*	*Dollars*
District 1						
Vermont	97,000	100.0	48,500	. .	.	
New Hampshire	43,000	100.0	43,000	. .	.	
District	140,000	100.0	46,667	. .	.	
District 2						
Pennsylvania	.	.		82,000	100.0	82,000
Virginia	.	.		587,100	100.0	587,100
West Virginia	150,000	85.7	150,000	25,000	14.3	25,000
District	150,000	17.8	150,000	694,100	82.2	57,842
District 3						
North Carolina	1,027,200	28.3	93,382	2,602,207	71.7	28,000
South Carolina	674,200	18.9	37,455	2,895,578	81.1	37,605
Georgia	1,755,695	15.7	39,902	9,423,528	84.3	28,668
Florida	2,801,500	50.5	254,682	2,746,900	49.5	105,650
District	6,258,595	26.2	75,405	17,668,213	73.8	33,590
District 4						
Tennessee	.	.	.	22,000	100.0	22,000
Indiana		.		40,000	100.0	40,000
District	. .	.	.	62,000	100.0	31,000
District 5						
Alabama	4,390,450	51.8	93,307	4,083,097	48.2	55,245
Mississippi	702,815	29.1	39,045	1,710,108	70.9	31,093
Louisiana	436,612	39.5	25,683	667,706	60.5	39,277
District	5,529,877	46.1	67,413	6,460,911	53.9	44,267
District 6						
Arkansas	154,420	25.5	51,473	451,735	74.5	75,289
District 10						
Texas	511,750	31.0	25,587	1,141,150	69.0	39,350
District 11						
California	1,410,700	48.8	470,233	150,000	51.2	253,333
District 12						
Oregon	8,400	1.3	8,400	666,800	98.7	17,139
Washington	25,000	1.2	25,000	2,138,000	98.8	76,357
District	33,400	1.2	16,700	2,804,800	98.8	50,086
United States	14,186,725	31.5	70,231	30,804,926	68.5	39,595

those on partially timbered lands. The difference was particularly outstanding in North Carolina, where the ratio was more than 3 to 1. In other southern districts the ratios are somewhat different. Thus in Alabama loans on completely forested tracts averaged about 70 percent higher than loans on partly stocked timberland, and in Mississippi completely forested tracts ran 25 percent higher. In Arkansas, Louisiana, and Texas the reverse was true —loans on partially timbered acreage averaged 50 percent higher than loans on all-forested lands.

Acreage on completely forested tracts averages much more than the woodland area of partly forested collateral in all States except Arkansas, Texas, and Washington (table 7). The differences are particularly noticeable in district 3; here the ratio is 3 to 1 for the district and 9 to 1 for North Carolina.

Table 7.—*Forest acreage collateral by tract type, October 1966*

District and State	Tracts entirely forested			Tracts partly forested		
	Aggregate size	Proportion of total forest collateral	Average size	Aggregate size	Proportion of total forest collateral	Average size
	Acres	*Percent*	*Acres*	*Acres*	*Percent*	*Acres*
District 1						
Vermont	7,591	100.0	3,796	.	...	..
New Hampshire	3,934	100.0	3,934	.	...	.
District	11,525	100.0	3,842	...	...	...
District 2						
Pennsylvania	.	.		1,000	100.0	1,000
Virginia		.	.	17,571	100.0	1,757
West Virginia	7,382	88.4	7,382	967	11.6	967
District	7,382	27.4	7,382	19,538	72.6	1,628
District 3						
North Carolina	42,873	51.2	3,897	40,826	48.8	439
South Carolina	14,947	22.4	830	51,805	77.6	673
Georgia	55,373	21.0	1,204	208,722	79.0	638
Florida	76,095	59.1	6,918	52,469	40.9	2,018
District	189,288	34.9	2,201	353,822	65.1	677
District 4						
Tennessee	...	...	...	309	100.0	309
Indiana	...	...	...	110	100.0	110
District	...	...	...	419	100.0	209
District 5						
Alabama	99,164	53.1	2,066	87,643	46.9	1,201
Mississippi	14,846	28.4	873	37,459	71.6	669
Louisiana	10,062	58.1	559	7,249	41.9	453
District	124,072	48.4	1,495	132,351	51.6	912
District 6						
Arkansas	3,241	14.3	1,080	19,487	85.7	3,248
District 10						
Texas	14,494	31.7	690	31,287	68.3	1,117
District 11						
California	22,249	34.8	7,416	41,713	65.2	6,952
District 12						
Oregon	230	7.4	230	2,880	92.6	103
Washington	160	.7	160	23,757	99.3	848
District	390	1.4	195	26,637	98.6	476
United States	372,641	37.0	1,845	625,254	63.0	804

Land and timber values vary widely.—The "normal" value per acre of collateral woodland differs widely throughout the United States, as might be expected (table 8). About half the tracts are appraised at less than $60 an acre and 11 percent at less than $30. About 19 percent—mostly recent collateral—are valued at $100 or more. The highest appraisal is $890.90 per acre and the lowest is $3.16. Loans in the Western States are generally on high-value security—over 80 percent of the tracts in California, Washington, and Oregon are appraised at more than $100 per acre. Most contracts in districts 2, 4, and 6 also are on woodland with high values per acre—primarily because the notes are recent and reflect current appraisals.

The lowest valuations are generally on southern woodlands. These reflect a preponderance of old appraisals as well as the inclusion of many acres of low-grade timber. But wide differences still exist among States in this region. In South Carolina, North Carolina, and Georgia about half the appraisals are for less than $60 per acre, but in Florida the proportion is 70 percent. In district 5, Louisiana tracts are valued higher than those in Alabama and Mississippi. Sixty percent of the collateral in Louisiana is appraised at more than $60 an

Table 8.—*Number of loans by appraised value of forest acreage held in collateral, October 1966*

District and State	Value per acre (dollars)													
	0-19.99		20-39.99		40-59.99		60-79.99		80-99.99		100-199.99		200+	
	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
District 1														
Vermont	1	50.0	1	50.0		.		.		.		.		.
New Hampshire	1	100.0		.		.		.		.		.		.
District	2	66.7	1	33.3		.		.		.		.		.
District 2														
Pennsylvania		.		.		.		.		.	1	100.0		.
Virginia	1	10.0	1	10.0		.	2	20.0	1	10.0	4	40.0	1	10.0
West Virginia		.	1	50.0	1	50.0		.		.		.		.
District	1	7.7	2	15.4	1	7.7	2	15.4	1	7.7	5	38.4	1	7.7
District 3														
North Carolina	5	4.8	16	15.6	24	23.3	13	12.6	20	19.4	20	19.4	5	4.9
South Carolina	4	4.2	22	23.1	22	23.1	16	16.9	10	10.5	18	19.0	3	3.2
Georgia	7	1.9	90	24.1	100	26.8	88	23.5	48	12.9	40	10.8		.
Florida	5	13.5	13	35.2	8	21.6	5	13.5	3	8.1	3	8.1		.
District	21	3.4	141	23.2	154	25.3	122	20.1	81	13.3	81	13.4	8	1.3
District 4														
Tennessee		...		.		.		.	1	100.0		.		.
Indiana		.		.		.		.		.	1	100.0		...
District		.		.		.		.	1	50.0	1	50.0		.
District 5														
Alabama	4	3.3	32	26.5	30	24.8	24	19.8	19	15.7	12	9.9		.
Mississippi		.	19	25.9	25	34.2	17	24.0	5	6.7	5	6.6	2	2.6
Louisiana	1	2.9	4	11.7	9	26.5	5	14.7	3	8.8	10	29.5	2	5.9
District	5	2.2	55	24.1	64	28.1	46	20.2	27	11.9	27	11.8	4	1.7
District 6														
Arkansas		...	2	22.2	2	22.2	2	22.2	2	22.3	1	11.1		...
District 10														
Texas	1	2.0	10	20.5	23	47.0	7	14.3	1	2.0	6	12.2	1	2.0
District 11														
California		...		...	1	11.1		...	3	33.3	4	44.4	1	11.1
District 12														
Oregon		.		.	2	6.9		.	2	6.9	5	17.3	20	68.9
Washington		.	1	3.5	1	3.5	2	6.9	1	3.5	5	17.2	19	65.4
District		.	1	1.7	3	5.2	2	3.5	3	5.2	10	17.2	39	67.2
United States	30	3.1	213	21.7	248	25.3	181	18.5	119	12.1	135	13.8	54	5.5

acre, as compared to 40 and 45 percent of that in Mississippi and Alabama.

In general, large collateral woodlands in the South tend to be worth more per acre than small because they are usually better managed and stocked. This difference is not apparent in the Pacific Northwest and California, however, where many small tracts have high appraisals.

Loan terms differ.—Most of the 980 active loans were for either 20 or 30 year terms—44 percent for 20 and 37 percent for 30 (table 9). Three loans were for the minimum time of 5 years and 29 for the maximum of 40. Some differences are apparent among States and districts.

Almost 60 percent of the notes in three of the four southeastern States of district 3 were for 30 or more years. But in South Carolina loans tend to be made for lesser periods. In the three Midsouth States of district 5, by way of contrast, only about 15 percent of the contracts were for 30 years or longer. All Texas loans and 90 percent of those in Oregon and Washington were for 20 years.

Fully amortized loans predominate.—More than 97 percent of the current loans are being liquidated under one of the two fully amortized payment plans (table 10). About three-fourths of these notes are being liquidated on the Springfield plan, whereby the borrower annually retires a fixed portion of the principal and pays interest on the unpaid balance. The remainder were on the Standard plan, in which the total payment of principal and interest is the same at each installment date.

Only 26 contracts were on a partially amortized basis. In these, payment on the principal is deferred for a specified number of years, but interest is paid periodically. Most are in district 5—17 in Alabama and five in Mississippi. Three were written in Virginia and one in Vermont.

More than 90 percent of the loans in the southeastern States of district 3 were on the decreasing payment plan. In districts 5, 6, 10, 11, and 12, however, the majority of notes were even payment. All Texas contracts were even payment, as were 80 percent in Arkansas and 90 percent in Oregon and Washington.

Most loans were contracted on an annual installment basis. About 7 percent provided for semiannual and 2 percent for either quar-

Table 9.—*Number of loans by length of term, October 1966*

Term (years)	District 1		District 2		District 3		District 4		District 5		District 6		District 10		District 11		District 12		United States	
	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
5			1	7.7					2	0.9									3	0.3
8									1	.4									1	.1
10			2	15.4	6	0.9			12	5.2							3	5.1	23	2.3
15	1	33.3	2	15.4	8	1.3			11	4.8									22	2.2
16									2	.9									2	.2
17					1	.2													1	.1
20	2	66.7	6	46.1	191	31.3	2	100.0	123	53.9	6	66.7	49	100.0			52	89.7	431	44.0
21									2	.9									2	.2
23									2	.9									2	.2
24									2	.9									2	.2
25			2	15.4	40	6.6			35	15.4					3	33.3			80	8.2
26					1	.2													1	.1
27					1	.2													1	.1
28									2	.9									2	.2
30					325	53.4			27	11.8					6	66.7	1	1.7	359	36.6
32					1	.2													1	.1
35					9	1.5			4	1.8	3	33.3					2	3.5	18	1.8
40					26	4.2			3	1.3									29	3.1

Table 10.—*Number of loans by repayment plan, October 1966*

District and State	Even payment		Decreasing payment		Other	
	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
District 1						
Vermont		...	1	50.0	1	50.0
New Hampshire		.	1	100.0		...
District	.	.	2	66.7	1	33.3
District 2						
Pennsylvania		..	1	100.0	...	...
Virginia	2	20.0	5	50.0	3	30.0
West Virginia	2	100.0	..	..	.	...
District	4	30.8	6	46.2	3	33.0
District 3						
North Carolina	4	3.9	100	96.1	. .	...
South Carolina	5	5.2	90	94.8	. .	...
Georgia	20	5.4	353	94.6		...
Florida	6	16.2	31	83.8		...
District	35	5.7	574	94.3	. .	...
District 4						
Tennessee	.	..	1	100.0	.	.
Indiana	.	...	1	100.0	.	...
District	...	..	2	100.0	...	...
District 5						
Alabama	62	51.2	42	34.7	17	14.1
Mississippi	30	41.1	38	52.1	5	6.8
Louisiana	19	55.9	15	44.1	. .	...
District	111	48.7	95	41.7	22	9.6
District 6						
Arkansas	7	77.8	2	22.2	...	...
District 10						
Texas	49	100.0	...	...	...	...
District 11						
California	5	55.6	4	44.4	...	...
District 12						
Oregon	26	89.7	3	10.3	...	...
Washington	26	89.7	3	10.3	...	...
District	52	89.7	6	10.3	...	...
United States	263	26.8	691	70.5	26	2.7

terly or monthly payments. A few were written for payments every 2, 3, 4, or 5 years. A number of notes specified deferral periods—usually 1 to 3 years—before periodic payments were to begin.

Many loans are refinanced.—More than one-third of the active loans had been refinanced. Most were in district 3, where 60 percent of the contracts were in this category. The bulk of the remainder were in district 5. As may be expected, there were few refinanced loans in districts with the newer programs.

Timber collateral mostly softwood.—Nearly all the active loans are on tracts where the dominant timber is softwood. Only a handful of hardwood loans—mostly in the South—are included, but many southern tracts used as collateral contain some merchantable hardwood whose value was included in the appraisal. Redwood, Douglas-fir, and pine are all

major collateral in California. In the Pacific Northwest most of the security is Douglas-fir, but a few of the loans are on hemlock and pine stands.

THE BORROWERS

Most borrowers are individuals.—More than 90 percent of the active loans are to individuals (table 11). Seven percent of the contracts are with partnerships and the remainder with corporations and trusts. In Texas, a considerably larger percentage of loans—about one-third—were granted to nonindividuals than in any other State or district. Three States—South Carolina, Georgia, and Texas—account for nearly three-fourths of the partnership loans.

Partnerships and corporations generally borrow more than do individuals. In district 3, partnership and corporation loans were 8 percent of the total number but 17 percent of the total amount. In district 5 the correspond-

Table 11.—*Number of loans by type of borrower, October 1966*

District and State	Individuals		Partnerships		Corporations and trusts	
	Loans	Proportion of total	Loans	Proportion of total	Loans	Proportion of total
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
District 1						
Vermont	1	50.0			1	50.0
New Hampshire					1	100.0
District	1	33.3			2	66.7
District 2						
Pennsylvania	1	100.0				
Virginia	9	90.0	1	10.0		
West Virginia	2	100.0				
District	12	92.3	1	7.7		
District 3						
North Carolina	101	97.0	1	1.0	2	2.0
South Carolina	78	82.1	14	14.7	3	3.2
Georgia	350	93.8	21	5.7	2	.5
Florida	29	78.4	5	13.5	3	8.1
District	558	91.6	41	6.7	10	1.7
District 4						
Tennessee	1	100.0				
Indiana	1	100.0				
District	2	100.0				
District 5						
Alabama	111	91.7	7	5.8	3	2.5
Mississippi	70	95.9	1	1.4	2	2.7
Louisiana	30	88.2	4	11.8		
District	211	92.5	12	5.3	5	2.2
District 6						
Arkansas	8	88.9			1	11.1
District 10						
Texas	33	67.3	15	30.6	1	2.1
District 11						
California	9	100.0				
District 12						
Oregon	26	89.7			3	10.3
Washington	27	93.1			2	6.9
District	53	91.4			5	8.6
United States	887	90.5	69	7.0	24	2.5

ing proportions were 8 and 16 percent. The difference is particularly noticeable in the Pacific Northwest—91 percent of the Oregon and Washington notes were made to individuals but the value of these contracts was only 32 percent of the total.

In most districts and States, the forest acreage collateral of individual borrowers averages much less than that of corporations and partnerships. Again this difference is most striking in Oregon and Washington, where individuals hold 91 percent of the loans but possess only 21 percent of the timber collateral.

Most borrowers are middle-aged.—Of the 887 individual borrowers, 82 percent were 40 years or older when they made application (table 12). And 47 percent were at least 50 years old. Only 25 persons were under 30 when they applied. The youngest borrower was 22 and the oldest 87.

Borrowers in the gulf South tend to be much older than those in the southeast. Those 50

Table 12.—*Age distribution at time of application for individual borrowers with active loans in October 1966*

District and State	Age (years)									
	0-29		30-39		40-49		50-59		60+	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
District 1										
Vermont							1	100.0		
New Hampshire										
District							1	100.0		
District 2										
Pennsylvania							1	100.0		
Virginia	1	11.1			3	33.3	3	33.3	2	22.3
West Virginia					1	50.0			1	50.0
District	1	8.4			4	33.3	4	33.3	3	25.0
District 3										
North Carolina	1	1.0	19	18.8	37	36.7	24	23.7	20	19.8
South Carolina			11	14.2	33	42.9	24	31.2	9	11.7
Georgia	13	3.7	61	17.4	118	33.8	90	25.7	68	19.4
Florida			4	14.3	11	39.3	8	28.6	5	17.8
District	14	2.5	95	17.1	199	35.8	146	26.3	102	18.3
District 4										
Tennessee					1	100.0				
Indiana			1	100.0						
District			1	50.0	1	50.0				
District 5										
Alabama	4	3.6	14	12.7	45	40.9	29	26.4	18	16.4
Mississippi	1	1.6	12	17.1	16	22.8	26	37.1	15	21.4
Louisiana			3	10.4	9	31.0	8	27.6	9	31.0
District	5	2.5	29	13.9	70	33.4	63	30.1	42	20.1
District 6										
Arkansas					3	37.5	4	50.0	1	12.5
District 10										
Texas	2	6.1	2	6.1	7	21.2	10	30.3	12	36.3
District 11										
California			2	22.2	2	22.2	3	33.4	2	22.2
District 12										
Oregon	1	3.8	1	3.8	13	50.0	7	27.0	4	15.4
Washington	2	7.4	2	7.4	11	40.7	10	37.1	2	7.4
District	3	5.7	3	5.7	24	45.2	17	32.1	6	11.3
United States [1]	25	2.8	132	14.9	310	35.1	248	28.1	168	19.1

[1] No age information was available for four individual borrowers.

years or older make up a larger proportion in Mississippi, Louisiana, Texas, and Arkansas than in the other Southern States.

Most borrowers have substantial income.—Woodland owners served by the land banks have relatively high incomes (table 13). Well over half of the individual borrowers reported total annual incomes exceeding $10,000 and more than 80 percent received at least $6,000. Almost 70 percent of the partnerships had income of at least $20,000 per year and only 10 percent earned below $10,000. Income of nearly two-thirds of the corporations exceeded $10,000.

Table 13.—*Income range at time of application for borrowers with active loans in October 1966* [1]

Income range (dollars)	Individuals		Partnerships		Corporations and trusts	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
0- 2,999	43	4.8	2	2.9	2	12.5
3,000- 5,999	121	13.8	1	1.5	2	12.5
6,000- 9,999	230	26.2	4	5.9	2	12.5
10,000-14,999	173	19.7	5	7.4	1	6.2
15,000-19,999	103	11.7	9	13.2	1	6.2
20,000-49,999	148	16.8	26	38.2	3	18.8
50,000-99,999	46	5.2	11	16.2	3	18.8
100,000+	16	1.8	10	14.7	2	12.5
Total	880	100.0	68	100.0	16	100.0

[1] No income information was available for 16 borrowers.

Most borrowers were receiving annual income from their woodlands at the time they made their loan applications. The proportion was 100 percent in 11 States. It exceeded 75 percent in all States except Texas, where it was 55 percent.

The average annual income from woodland security was highest in California at almost $57,000 and lowest in Washington at less than $1,000. It was more than $5,000 in 12 of the 19 States and exceeded $10,000 in four States.

Net worth differs by type of borrower.—Corporations served by the land bank timber programs borrow more heavily than do individual and partnership clients (table 14).

Only 2 percent of the individuals and 6 percent of the partnerships with loans in October 1966 had debts exceeding 50 percent of their assets. Three out of five borrowers in each category owed less than 20 percent.

In contrast, about 17 percent of the borrowing corporations had current liabilities exceeding 50 percent of their assets. Only two out of five were in debt to an amount of 20 percent or less.

Table 14.—*Ratio of debts to assets at time of application, for borrowers with active loans in October 1966*

Ratio of debts to assets (percent)	Individuals		Partnerships		Corporations and trusts	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
0- 9.9	252	28.4	17	24.6	4	17.4
10-19.9	268	30.2	25	36.2	6	26.1
20-29.9	210	23.7	16	23.2	4	17.4
30-39.9	94	10.6	3	4.4	3	13.0
40-49.9	44	5.0	4	5.8	2	8.7
50-59.9	14	1.6	4	5.8	3	13.0
60-69.9	5	.5		.	1	4.4
70-79.9		.		...		.
80-89.9		...		.		.
90-100		.		.		.
Total	887	100.0	69	100.0	[1] 23	100.0

[1] No information was available for one corporate borrower.

Loan purposes are varied and many.—The most prevalent reasons for borrowing were to purchase or refinance all or part of the security. Nearly one-fourth of the loans were used solely for these purposes (table 15) and many more partially. Only 10 of the 980 borrowers applied the proceeds entirely for forestry purposes. But 59 more channeled some of the funds into forestry, primarily for timber improvement.

Other important reasons for borrowing were to refinance short-term debt and to build, purchase, or remodel houses and buildings. Miscellaneous uses not shown in the table include establishing small businesses, buying cattle, financing children's college educations, and paying property and income taxes.

Some interstate differences are important. About 60 percent of the loans in Texas and Alabama were used for single purposes. This proportion was much lower in the other States, particularly in California and Florida. In North and South Carolina, Alabama, Texas, and California, a much larger percentage of borrowers utilized their proceeds to purchase all or part of the security than was true in other States. This reason was least important in Mississippi and Oregon. Few Washington and Louisiana loans were used to refinance mortgages on the security—the percentage in the other States was considerably higher. Less than 2 percent of the west coast and Texas borrowers refinanced existing short-term debt with loan proceeds—in the other States a much larger proportion did so.

Table 15.—*Proportion of loans by purpose, for those current in October 1966*

District and State	Loans	Timber stand improvement	Purchase woodland security	Purchase other land	Refinance mortgage on security	Refinance short-term debt	Farm operating expenses	Buy, remodel or construct buildings	Inheritance and estate taxes	Other	Mixture
	Number	*Percent*									
District 1											
Vermont	2	.	...	...	...	50.0	.	.	.	.	50.0
New Hampshire	1	.	.	.	.	.	.	.	.	.	100.0
District	3	.	..	..	.	33.7	.	.	.	.	66.7
District 2											
Pennsylvania	1	...	..	...	..	.	.	.	.	.	100.0
Virginia	10	.	10.0	...	40.0	.	.	...	...	.	50.0
West Virginia	2	.	50.0	...	.	..	.	.	.	.	50.0
District	13	..	15.4	..	30.8	.	.	.	.	.	53.8
District 3											
North Carolina	104	.	18.3	1.0	11.5	6.7	.	3.8	.	2.9	55.8
South Carolina	95	1.0	17.9	3.2	15.8	1.0	2.1	6.3	.	5.3	47.4
Georgia	373	.	8.6	3.2	9.7	7.0	3.5	5.1	0.8	4.0	58.1
Florida	37	.	8.1	2.7	8.1	10.8	.	.	.	.	70.3
District	609	.1	11.7	2.8	10.8	6.2	2.5	4.8	.5	3.8	56.8
District 4											
Tennessee	1	.	.	.	.	...	.	.	...	.	100.0
Indiana	1	.	100.0	.	.	.	.	.	.	.	.
District	2	.	50.0	.	.	.	.	.	.	.	50.0
District 5											
Alabama	121	1.7	16.5	3.3	9.9	8.3	3.3	6.6	.8	9.1	40.5
Mississippi	73	.	2.9	2.7	12.4	2.7	4.1	9.6	.	5.5	60.3
Louisiana	34	.	5.9	2.9	5.9	5.9	8.8	.	2.9	14.7	53.0
District	228	.9	10.5	3.1	10.1	6.1	4.4	6.6	.9	8.8	48.6
District 6											
Arkansas	9	.	.	...	11.1	11.1	...	11.1	.	11.1	55.6
District 10											
Texas	49	8.2	18.4	4.1	12.2	...	6.1	6.1	...	6.1	38.8
District 11											
California	9	.	22.2	...	...	...	...	...	11.1	...	66.7
District 12											
Oregon	29	10.3	3.5	6.9	.	.	6.9	3.5	.	20.7	48.2
Washington	29	.	6.9	13.7	3.5	3.5	.	3.5	.	13.7	55.2
District	58	5.2	5.2	10.3	1.7	1.7	3.5	3.5	.	17.2	51.7
United States	980	1.0	11.4	3.3	10.3	5.6	3.1	5.1	.6	5.8	53.8

IMPLICATIONS FOR FOREST MANAGEMENT

Few land bank timber loans have been used for forestry purposes in the past. Recent innovations in the programs, however, are making it more feasible than ever before to tailor borrowing to woodland management and improvement. Loan funds can now be obtained and used to improve stand quality as well as to purchase additional woodlands.

The low rates and flexibility in adjusting contracts to meet individual requirements make Federal land bank loans especially useful to owners of small tracts. The programs can also be of considerable benefit to holders of large acreages. Liquidating immature but merchantable timber to raise cash is usually far less profitable than using the timber as loan collateral. Young timber in many areas earns at rates far in excess of what credit costs.

Forest investments will become increasingly attractive as the knowledge that woodland can be used as loan security becomes more widespread. But the extent to which credit will be used for forestry purposes will depend less on the land banks than on the forestry profession. The primary interest of the banks is to insure that the woodland collateral is managed so as to protect bank funds. Promoting good forestry is important but only a byproduct.

Private consulting, industrial conservation, and public farm foresters are in an ideal position to promote the use of credit. When the

rate of return from holding growing timber exceeds loan costs, they can demonstrate the fact to owners. Foresters can also diagnose stand conditions, prescribe treatments, and evaluate possible earnings from various management alternatives. Such analyses can indicate the most advantageous ways for using land bank loan funds. To give foresters their fullest opportunities, banks with existing timber-loan programs should periodically reexamine their policies for alternatives which will better serve prospective clientele.

From a forester's viewpoint, forest credit of some type seems feasible in those districts now without it. All districts have some areas where timber growth and markets are such that private forestry is profitable.

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Location of Laminae by Elastic Modulus May Permit Manufacture of Very Strong Beams from Rotary-Cut Southern Pine Veneer

Peter Koch

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Location of Laminae by Elastic Modulus May Permit Manufacture of Very Strong Beams from Rotary-Cut Southern Pine Veneer [1]

Peter Koch

In the United States, beams having outer laminae of upper grades of 1-inch kiln-dry southern pine lumber are assigned maximum allowable design values as follows:

modulus of elasticity (MOE)	1,800,000 p.s.i.
stress in bending	2,600 p.s.i.
stress in horizontal shear	200 p.s.i.

It has been the objective of a series of experiments at the Alexandria, Louisiana, laboratory of the Southern Forest Experiment Station to: (1) utilize the full range of grades of wood as they naturally occur in small as well as in large trees (i.e., log-run), rather than the highly selected grades specified for the present high-performance beams, and (2) to develop an economic ordered assembly system that will increase allowable working values for MOE and stress in bending by one-third, i.e., to 2.4 million and 3,470 p.s.i. respectively. Accomplishment of these objectives would permit laminated wood to compete more effectively with steel bar joists in light commercial construction.

Before describing progress toward the objectives, it is pertinent to state the requirements that must be satisfied before allowable

[1] A summary of this paper was presented before Section 41, Fourteenth Congress, International Union of Forestry Research Organisations, Munich, West Germany, September 1967.

working strengths for bending can be assigned. It is assumed that a specific product is in mind, for example, a 2-inch-wide laminated beam, 18 inches deep and 25 feet long.

Allowable working MOE is simply the average MOE observed in a representative random sample of the population of the specific beams in question. Therefore, the proposed beams must have an average effective MOE (corrected for shear) of 2.4 million p.s.i.

A recognized allowable working bending stress for a specific population of beams can be calculated by breaking a random sample of the beams, then calculating the 95-percent exclusion limit for modulus of rupture (MOR)—i.e., a level of MOR selected so that 95 percent of the beams in the population exceed the level—and finally dividing this value by 2.1 *(1)*. This overall factor 1 2.1 is the product of three component factors: 9/16 for duration of load, 11/10 for normal loading, and 10/13 for factor of safety.

In other words, for a specific beam population to have an assigned working allowable bending stress of 3,470 p.s.i., the 95-percent exclusion limit for MOR must be established by test to equal or exceed (2.1)(3,470), or 7,290 p.s.i.

Trees available for harvest in the United States are generally smaller and of lower grade than those harvested in previous years. In recognition of this fact, research was begun at Alexandria, Louisiana, during 1963 to devise a conversion process that would utilize small trees.

An initial development was the invention of a system for manufacturing beams by placing stiff laminae in the outermost tension and compression zones of the beams, and limber laminae in the less highly stressed central zone *(2)*. The arrangement takes advantage of the natural variation in southern pine wood and yields beams of high and relatively uniform strength. Elements of the manufacturing system are diagrammed in figure 1.

The basic idea of arranging laminae by elastic modulus stimulated execution of a series of experiments leading to the hypothesis stated in the introductory paragraphs.

By consideration of the variation in elastic properties it is possible to calculate the bending stiffness (EI) for a beam in which there is a gradient in elastic modulus from the neutral axis to the top and bottom laminae. For such a beam there is no definitive elastic modulus of the wood *per se*, but there is a definite bending stiffness (EI). Hence, the term modulus of elasticity (MOE), as it is here applied to specific beams, should be interpreted as the "effective" or "apparent" MOE of the beam, rather than as a definitive MOE of any particular layer in the beam.

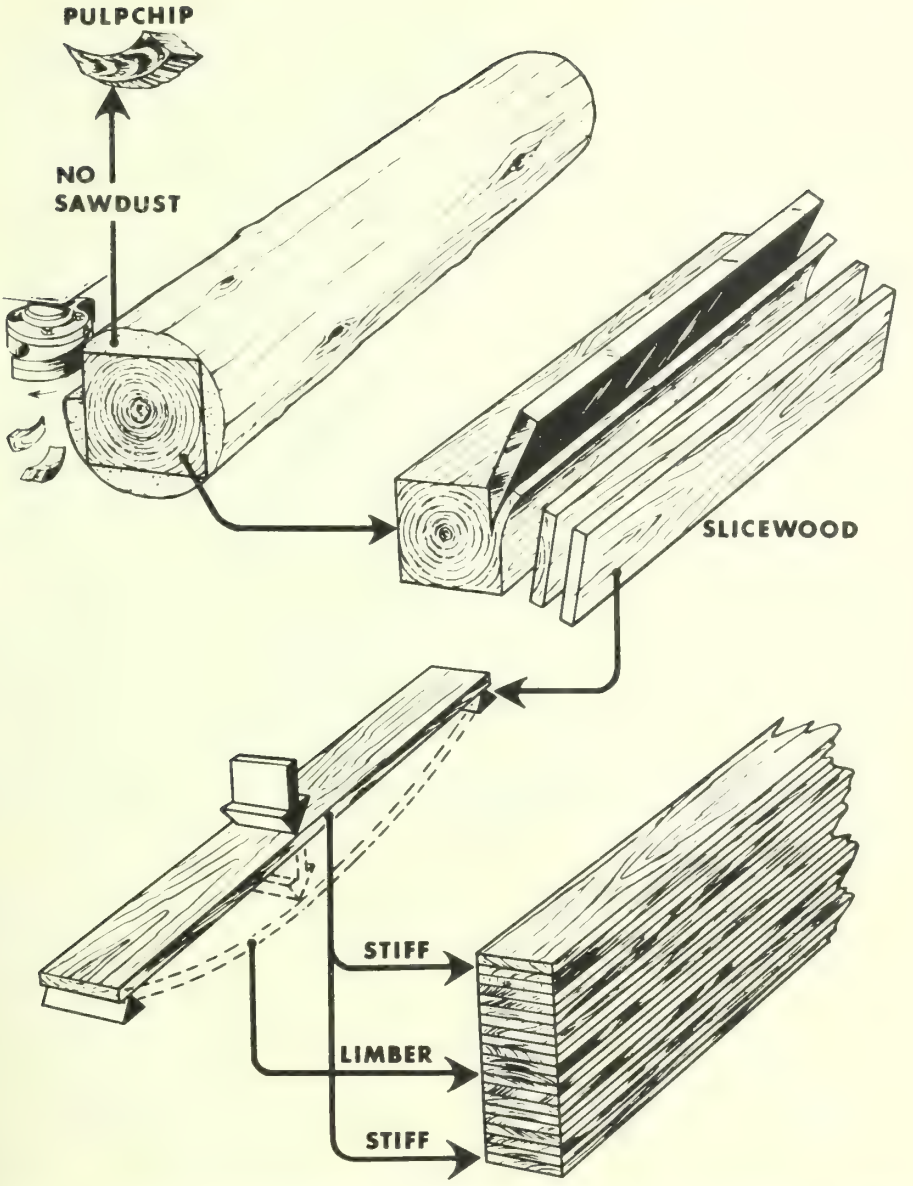

Figure 1.—*Concept of small-tree utilization to yield unusually strong, stiff beams having laminae arranged according to elastic modulus.*

REVIEW OF PROGRESS TO DATE

Evaluation of a system of assembling log-run, 1/3-inch-thick, sawn laminae according to elastic modulus. —Modulus of elasticity of the laminae comprising 25 beams averaged 1.7 million p.s.i. and

ranged from 740,000 to 3,370,000 p.s.i. Figure 2 shows laminae for a typical beam; figure 3 is a cross section of a beam made from the same laminae. The average range and distribution of MOE within a beam is charted in figure 4.

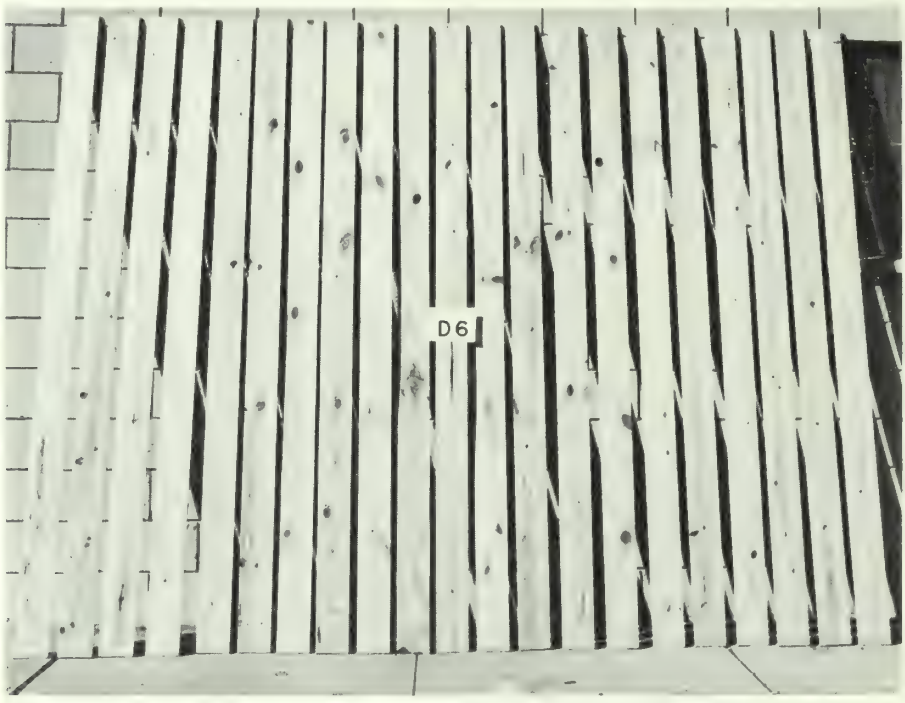

Figure 2.—*These 100-inch-long southern pine veneers comprise the beam illustrated in figure 3, arranged in order of assembly. The stiffest clear veneer (on the extreme left) was used for a tension skin and the next stiffest (extreme right) for a compression skin. With these exceptions, the veneers are in order of stiffness from outside to center without regard to visible defect.*

Tested in bending at 12-percent moisture content, the beams had an average MOR of 9,900 p.s.i. and an MOE of 1,820,000 p.s.i. Ninety-five percent of the population represented by the 25 beams could be expected to have an MOR in excess of 8,060 p.s.i. *(2)*.

The laminae were principally of loblolly pine *(Pinus taeda* L.), but with a scattering of shortleaf *(P. echinata* Mill.) and longleaf pine *(P. palustris* Mill.).

Determination of the effect of butt joints in the laminae.—A series of five 100-inch-long beams was fabricated with a single butt joint in each interior lamina. The tension and compression skins contained no joints. In other respects the beams were the same as those described above. Each butt joint was 100/19 or 5¼ inches

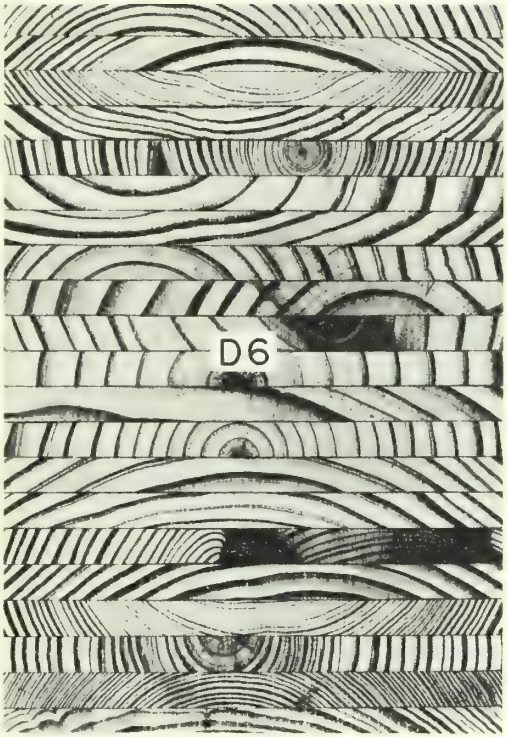

Figure 3.—
Typical beam cross section. All beams contained 21 laminae, each 1/3-inch thick. Placing the stiffest veneers toward the outside accomplished a certain gradation by ring width and percent of latewood. This beam had a modulus of rupture of 11,490 p.s.i. and a modulus of elasticity of 2,020,000 p.s.i.

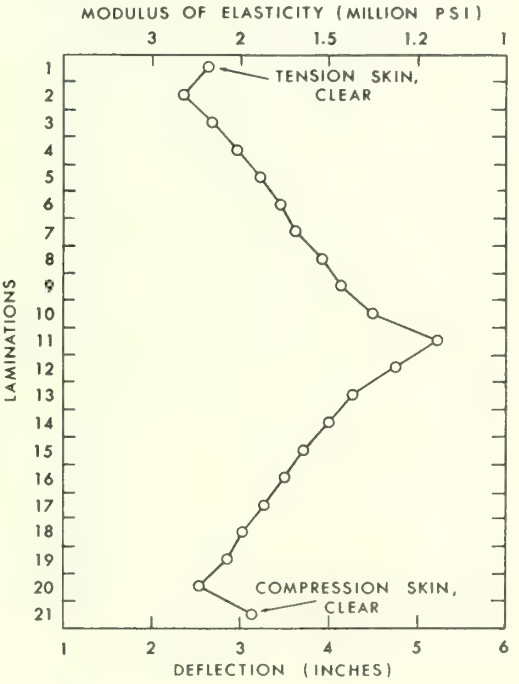

Figure 4.—
Average deflection and modulus of elasticity for 1/3-inch-thick veneers comprising laminae of the 25 beams. Each value is the average for 25 veneers. Deflections are for a center-point load of 1 pound per inch of lamina width over a 96-inch span.

(measured along the length of the beam) from the nearest joint on either side. The butt joints were spaced so that they formed, in effect, a staggered finger joint with tips of 1/3-inch thickness and zero slope on the fingers (fig. 5).

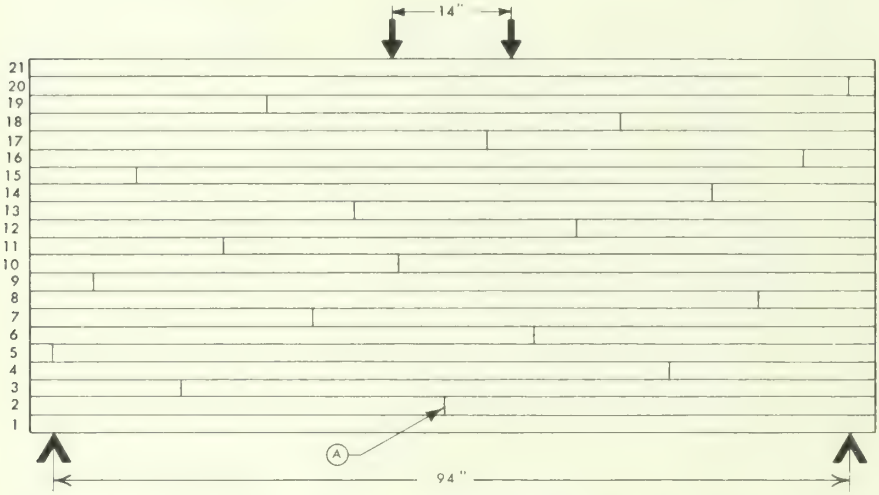

Figure 5.—*In this beam each of the 19 interior laminae contains a single butt joint, as indicated. The placement of the joints is such that the pattern forms an irregular finger joint. Butt joint at point A is at midspan of the second lamination on the tension side. All beams failed at this point.*

Average MOR was 7,300 p.s.i., with a 95-percent exclusion limit of 5,250 p.s.i. Average MOE was 1,840,000 p.s.i. *(2)*.

Comparison of various systems of placing laminae.—Beams representing four methods of assembly were laminated from twenty-one 1/3-inch-thick surfaced veneers 3 inches wide. The veneers were sawn from heart-center cants cut from 26-year-old slash pines *(Pinus elliottii* Engelm.) from a plantation in central Louisiana. Beams were 100 inches long and were tested at 9-percent moisture content. The assembly methods are listed below in descending order of strength and stiffness of the resulting beams *(4)*. Five beams were tested for each method:

(a) Stiffest veneers in outer laminae and limber veneers in inner laminae. Average MOR was 10,200 p.s.i. Of the beam population represented, 95 percent could be expected to have an MOR of 7,140 p.s.i. or higher. Average MOE was 2,130,000 p.s.i.

(b) Clearest veneers in outer laminae, knottiest in inner. MOR was 9,590 p.s.i. (95-percent exclusion limit of 5,960 p.s.i.), and MOE was 1,930,000 p.s.i.

(c) Veneers of high specific gravity in outer laminae and veneers of low specific gravity in inner laminae. MOR was 8,390 p.s.i. (95-percent exclusion limit of 4,790 p.s.i.), and MOE was 1,910,000 p.s.i.

(d) Veneers randomly placed. MOR was 6,630 p.s.i. (95-percent exclusion limit of 2,890 p.s.i.), and MOE was 1,620,000 p.s.i.

Evaluation of beams from thin, rotary-cut veneer.—Veneer 1/6-inch thick was rotary-peeled, hot, from east Texas logs (principally *Pinus taeda* and *P. echinata)* averaging 13 inches in diameter and seven rings per inch. The logs were relatively dense, averaging 50 percent latewood.

Three-inch-wide beams arranged by elastic modulus from such veneer (fig. 6) proved stronger and stiffer than beams similarly fabricated from 1/3-inch sawn veneer.

For five beams tested at 9-percent moisture content, average MOR (untransformed section) was 12,260 p.s.i., with 95-percent exclusion limit of 10,480 p.s.i. MOE was 2,330,000 p.s.i. Wood from the outer portion of a log usually is stronger than juvenile wood from the region of the pith. Thus it appears that, by rotary cutting of thin laminae, it is possible to locate superior wood for the critical tension laminae *(3).*

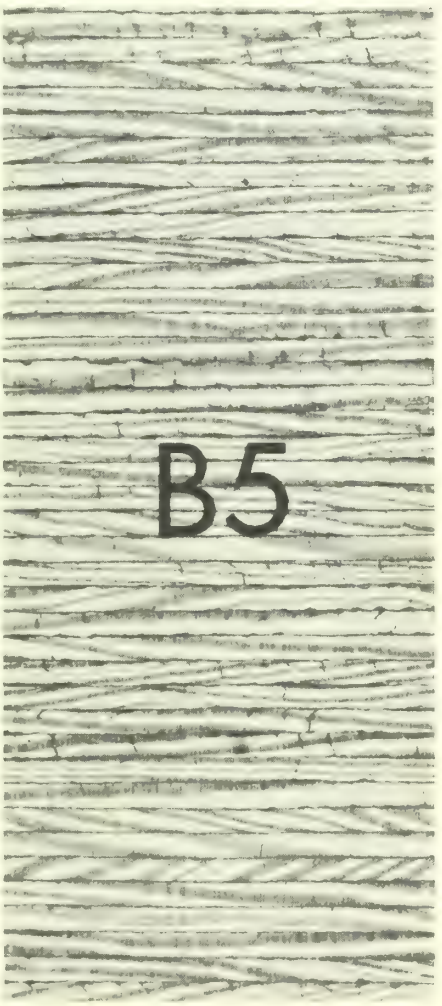

Figure 6.—
Typical cross section of 100-inch beam comprised of 42 rotary-peeled, 3-inch-wide laminae each 1/6-inch thick. Tight side of each veneer is outermost; tension side is on the bottom. This beam had an MOR (untransformed section) of 12,890 p.s.i. and an MOE of 2,210,000 p.s.i.

Effect of lamina width in beams of rotary-cut veneer.—When rotary-cut laminae similar to those described above were reduced from 3 inches to 2 inches in width prior to ranging by elastic modulus (fig. 7, beam E3), the range in lamina strength was increased. Hence, it was possible to identify even stronger wood for placement on the tension side. Five 100-inch-long beams, each comprised of forty-two 1/6-inch, rotary-cut veneers only 2 inches wide, had an average MOR (untransformed section) of 13,060 p.s.i., with a 95-percent exclusion limit of 11,340 p.s.i. Beam MOE was 2,460,000 p.s.i. Horizontal shear strength averaged 570 p.s.i. *(3).*

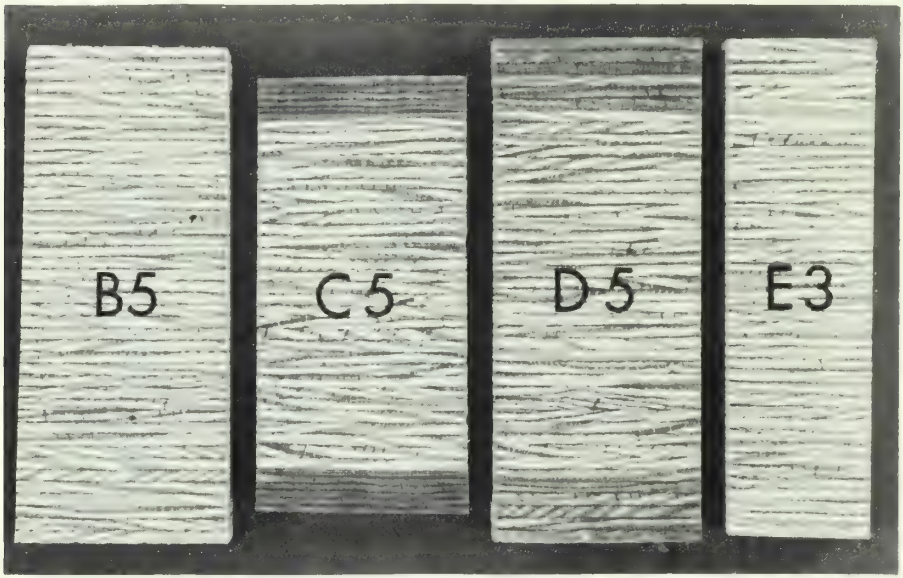

Figure 7.—*Typical cross sections of beams laminated from 42 rotary-cut, 1/6-inch veneers arranged by elastic modulus: B5—3-inch width untreated; C5—final six veneers on top and bottom densified by heat and pressure; D5—final six veneers on top and bottom impregnated with polymethylmethacrylate and irradiated; and E3—2-inch width untreated.*

Effect of strengthened flange material.—Three methods were tested for strengthening the beam parts subject to maximum tension and compression stress—i.e., the face or flange material.

(a) Five 100-inch beams were made with laminae placed by elastic modulus; laminae for each beam consisted of 21 veneers 1/3-inch thick and 3 inches wide. Veneers were sawn from heart-center cants cut from 26-year-old plantation-grown slash pines. Application (by epoxy adhesive) of high-strength aluminum alloy sheets 0.05 inch thick to tension and compression faces added 31 percent to the max-

imum load carried and increased stiffness (calculated by multiplying MOE times moment of inertia) by 25 percent. Variability was reduced. These increases apply to the beam strengths previously cited under systems of placing laminae *(4)*.

(b) Five 100-inch beams were laminated (with placement by elastic modulus); each beam contained 42 rotary-cut veneers 1/6-inch thick and 3 inches wide. The compression and tension flanges (each comprised of six 1/6-inch veneers) were densified to a specific gravity of 1.18 through the application of heat and pressure (fig. 7, beam C5). Average MOE of the 10 flanges (when tested separately) was increased from 2,510,000 p.s.i. prior to treatment to 4,560,000 p.s.i. after densification. Average beam MOR (untransformed section) was 16,560 p.s.i., with 95-percent exclusion limit of 13,300 p.s.i. MOR calculated on the basis of a transformed section averaged 22,090 p.s.i. Average beam MOE was 3,040,000 p.s.i. Laminae for these and the beams described in the following paragraph were primarily from loblolly and shortleaf pines grown in eastern Texas. They were carefully matched to the wood in the other tests with rotary-cut veneer *(3)*.

(c) In another five beams of rotary-cut veneers arranged by elastic modulus, the outer six laminae on both the tension and the compression sides of each beam were impregnated (68-percent loading) with polymethylmethacrylate and then irradiated (fig. 7, beam D5). The treated flanges then had a specific gravity of 1.07; their MOE rose from 2,520,000 to 2,870,000 p.s.i. Average beam MOR (untransformed section) was 14,180 p.s.i., with 95-percent exclusion limit of 10,440 p.s.i. MOR calculated on the basis of a transformed beam section averaged 15,030 p.s.i. Beam MOE was 2,570,000 p.s.i. *(3)*.

Comparison of horizontal and vertical placement of laminae.—An experiment was made (unpublished data on file at Alexandria, Louisiana, in U. S. Forest Service report SO-3601-2.18) to compare the virtues of: (1) randomly located, 3/4-inch-thick laminae with gluelines vertical; and (2) 3/4-inch laminae placed by elastic modulus with gluelines horizontal. The beams were 6 3/4 inches square and were each comprised of nine sawn laminae. Five beams were constructed of No. 1 common lumber (as graded by the Southern Pine Inspection Bureau), five were of No. 3 common lumber, and five were of grades 1 and 3 mixed.

Regardless of grade of the laminae, the beams were stiffest if the laminae were horizontally arranged (and placed in the beam

according to elastic modulus). Beams having random vertical arrangement of the laminae proved less stiff. Moisture content at test was 10.4 percent.

Lumber grade of laminae	Average MOE of beams	
	Gluelines vertical, laminae placed randomly	Gluelines horizontal, laminae placed by stiffness
	P.s.i.	*P.s.i.*
No. 1 common	1,940,000	2,130,000
Nos. 1 and 3 common mixed	1,700,000	2,020,000
No. 3 common	1,590,000	1,810,000

Effect of lamina thickness.—Effect of lamina thickness was studied (unpublished data on file at Alexandria, Louisiana, in U. S. Forest Service report SO-3601-2.12) on beams 6 inches deep, 3 inches wide, and 100 inches long. The beams were of log-run laminae sawn from 26-year-old plantation-grown slash pines in central Louisiana. Lamina thicknesses of ¼, ½, and 1 inch were evaluated— five beams in each group. Laminae in the central 2 inches of each beam had an average MOE of 1.5 million p.s.i., while the laminae in the outer 1-inch zone on compression and tension sides had an average MOE of 2.5 million p.s.i. The intermediate laminae were selected for an MOE of 2 million p.s.i. The beams, which averaged 0.57 in specific gravity (ovendry weight and volume at test), were destructively tested at 12-percent moisture content.

Thickness of laminae	Average MOR	95-percent exclusion limit, MOR
Inch	*P.s.i.*	*P.s.i.*
¼	10,800	8,010
½	11,030	8,720
1	9,420	3,760

It would appear that, when log-run laminae are arranged by MOE, beams of thin laminae are more uniform in strength than those of thick laminae.

DISCUSSION

Despite the obvious hazards of drawing conclusions from five-beam samples taken from limited geographic areas, the series of experiments suggests that southern pine beams of improved strength and stiffness can be made of thin, narrow, rotary-cut, log-run laminae

arranged by elastic modulus with gluelines oriented horizontally. It is believed that this line of research has shown the way toward a procedure for laminating beams that will justify allowable working stresses one-third higher than the present maximums.

Before this goal can be attained, considerable research must yet be accomplished on beams of commercial size—for example, 2 inches wide, 18 inches deep, and 25 feet long.

1. Thin, log-run, rotary-cut, loblolly pine laminae can be expected to display an average MOE of about 1.8 million p.s.i. and to range from a low of about 600,000 p.s.i. to a high of more than 3 million p.s.i. If a normal rather than a straight-line distribution of laminae is assumed, basic mechanics indicates that such laminae can be fabricated into 18-inch-deep beams having a theoretical MOE of approximately 2.2 million p.s.i. This calculation makes no allowance for the effect of butt joints; in fact, butt joints in such beams may reduce MOE by 50,000 to 100,000 p.s.i. Further, any inaccuracy in determining the MOE of individual veneers will bring beam MOE below the theoretical value. There also is some uncertainty about the shape of the distribution curve; lack of normality or skew in the distribution will alter the achievable beam MOE. With allowance for these factors, the predicted MOE of the proposed 18-inch loblolly pine beams is 2.1 million p.s.i.

It is probable that slash pine laminae displaying a normal distribution around an average MOE of 2.1 million p.s.i. (i.e., ranging from about 900,000 to over 3.3 million p.s.i.) can be assembled into 18-inch-deep beams having a MOE of close to 2.4 million p.s.i. Accurate evaluation of the MOE of rotary-cut veneer is a problem not yet solved.

2. It must be demonstrated in an 18-inch beam that carefully staggered butt joints located every 8 feet in every 1/6-inch lamina will not seriously reduce the beam MOE. Rotary-cut veneer is usually produced in 8-foot lengths. The experiment on the effect of butt joints in beams with 1/3-inch laminae indicates that this is probably possible.

3. For a beam of the size proposed, it must be demonstrated that butt joints every 8 feet in each thin lamina will not reduce the 95-percent exclusion limit for MOR below 7,290 p.s.i.

It has been noted that butt joints in all but the outer 1/3-inch-thick laminae reduced the 95-percent exclusion limit from 8,060 to 5,250 p.s.i. It is reasoned that thinner laminae (1 6-inch, for instance) would show less effect from butt joints even though 100 percent of the laminae contained them. In the experiment with dense rotary-cut laminae 2 inches wide, a 95-percent exclusion limit for

MOR of 11,340 p.s.i. was achieved. If the ratio described above (5,250:8,060) prevails for beams with butt joints compared to beams without butt joints, a 95-percent exclusion limit of 7,400 p.s.i. might be achievable with butt-jointed, 1/6-inch, rotary-cut laminae.

It is recognized that the depth effect—i.e., the loss of MOR with increased beam depth—will have to be completely offset by the increased strength of laminae available for placement in the outer zones of deeper beams. The choice among the greater number of laminae required for the construction of a deep beam should increase the probability of locating superior wood.

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DIRECT-SEEDING PINE
IN TENNESSEE'S HIGHLANDS

U. S. Forest Service Research Paper SO-31 1968

DIRECT-SEEDING PINE IN TENNESSEE'S HIGHLANDS

T. E. Russell and A. L. Mignery

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

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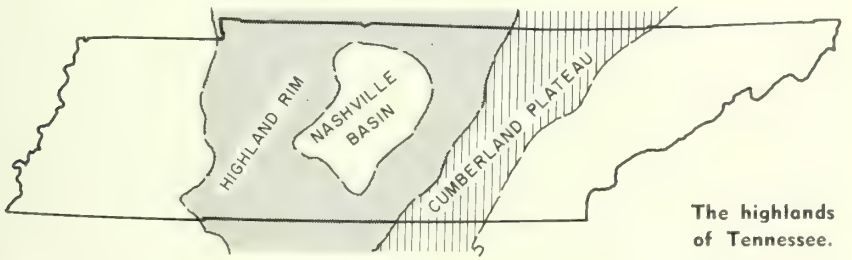
DIRECT-SEEDING PINE IN TENNESSEE'S HIGHLANDS

T. E. Russell and A. L. Mignery [1]

Vast areas currently occupied by hardwoods on the Cumberland Plateau and Highland Rim in Tennessee are better suited to pine. Loblolly, shortleaf, and Virginia pine seedlings are being planted extensively on ridges, thin-soiled rolling uplands, and rocky southerly slopes where hardwood growth is poor, but the procedure is expensive. The studies reported here show that direct seeding, which is cheaper than planting, is feasible in these highlands.

The research results apply directly to the Cumberland Plateau and Highland Rim of Tennessee, but they should also apply, with little modification, throughout surrounding areas of the southern Appalachians where soil, topography, and climate are comparable.

The Cumberland Plateau in Tennessee averages 1,700 to 2,000 feet above sea level, although the northeast section has mountains exceeding 3,000 feet. The major surface, underlain by sandstones, is dissected by young valleys whose steepness and depth increase abruptly into coves or gorges toward the edges. The plateau extends southwest from the Tennessee-Kentucky border, gradually lowering until it disappears beneath the Coastal Plain in northwest Alabama. Characteristic soils are of the Hartsells-Muskingum association—usually fine sandy loams to silt loams.



The highlands of Tennessee.

The Highland Rim is a low plateau formed primarily on limestone. It begins at the foot of the Cumberland Escarpment and, in Tennessee, surrounds the Nashville Basin and extends south and west to the Tennessee River. Elevations reach 1,100 to 1,300 feet at the foot

[1] The authors are stationed at the Sewanee Silviculture Laboratory, which is maintained by the Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, at Sewanee, Tennessee, in cooperation with the University of the South.

of the plateau and decrease westward to 700 feet near the Tennessee River. The western Highland Rim is strongly dissected with long, narrow ridges and steep-sided valleys. Characteristic soils here are Bodine and Baxter cherty silt loams and Mountview silt loams.

Climate during the growing season is more favorable for germination and seedling survival in the mountains of Tennessee than it is in the Coastal Plain. Rainfall in central Louisiana, where direct-seeding procedures were developed, is about the same as in Tennessee, but its spring and summer distribution is more uniform in Tennessee. In addition, it is cooler in the mountains than on the Coastal Plain, and hence, evapotranspiration is lower.

Winters are more severe in Tennessee than farther south, and seedling losses in the winter are sometimes greater than during the first summer. Frost heaving is a hazard on heavy soils that have been intensively prepared. Snow, ice, and winter injury caused some losses in our studies, but they were never serious enough to cause an otherwise successful seeding to be judged a failure.

Methods

Seven related studies were established between 1957 and 1963 to determine the modifications needed to adapt pine direct-seeding procedures to the highlands of Tennessee. Table 1 describes the sites and variables included in each study. Henceforth, the studies will be referred to by the numbers assigned in table 1.

Loblolly pine was seeded in all tests, shortleaf pine in three, and Virginia pine in four. Because the goal was to learn how to convert low-grade hardwood stands to pine, all study areas had a forest cover before treatment.

All studies of broadcast sowing tested a currently recommended repellent coating and seedbed preparation. Study 2 also evaluated three times of sowing and the three species of pine. Furrow-seeding trials compared 2 months of sowing for three pine species. Only repellent-treated seed was sown in the furrow-seeding trials and in subsequent studies. Studies 5 and 6 evaluated the effects of hardwood litter, sowing date, and stratification on spot-seeding success. Study 7 compared spot seeding and broadcasting of loblolly and Virginia pine.

In all studies, treatments were adequately replicated in randomized blocks or completely randomized designs. Site-preparation plots ranged in size from 0.1 acre in study 1 to 0.9 acre in study 2.

The repellent coating for seeds was a blend of Arasan-75 and Endrin 50-W, applied over a Dow Latex 512-R sticker.[2] Treated seeds

[2] Mention of trade names is for information only and does not imply endorsement by the U. S. Department of Agriculture.

Table 1.—*Site descriptions and variables tested*

Item	Study number and year installed						
	1 1957	2 1957-58	3 1959	4 1960	5 1961	6 1962	7 1963
Sowing method	Broadcast	Broadcast	Broadcast	Furrow	Spot seeding	Spot seeding	Spot and broadcast
Study area [1]							
Elevation	1,860 feet	1,860 feet	1,500 feet	1,940 feet	1,940 feet	1,940 feet	850 feet
Topographic position	Broad ridge	Broad ridge	Escarpment	Undulating flat	Broad ridge	Ridge	Upper slope
Slope	0-12%	0-8%	25%	0-5%	2%	0-15%	40-70%
Aspect	S and SE	S and N	W and SW	Variable	S	W to SW	W to NW
Soil series	Hartsells	Hartsells	Limestone rockland	Hartsells & Muskingum	Hartsells	Hartsells & Muskingum	Mountview & Bodine
Variables							
Repellent treatment	X	X	X				
Seedbed preparation	X	X	X			X	
Seedspot preparation					X	X	
Stratification					X	X	
Month of seeding		X		X	X		
Species [2]		X					X
Seeding method							X

[1] Studies 1 through 6 were on the Cumberland Plateau in Franklin County; study 7 was on the western Highland Rim in Hickman County.

[2] Studies 1, 5, and 6 tested only loblolly pine. In studies 3 and 4, loblolly, shortleaf, and Virginia pine were tested on adjacent areas, but species was not an experimental variable. Study 2 included loblolly, shortleaf, and Virginia pine as replicated and randomly assigned experimental variables. Study 7 compared loblolly and Virginia pine on replicated plots.

were also lightly coated with powdered aluminum. Arasan was applied at 5.4 to 6.6 percent of the dry weight of seeds, and endrin, 1.0 to 2.0 percent. The high rates were used for furrow and spot seeding.

Release from hardwoods was not an experimental variable; all direct-seeded pines in each study were released uniformly. Hardwoods in studies 1 and 2 were deadened 1 year after seeding. In later studies, hardwoods that survived initial site preparation were deadened promptly by frilling, tree injection, basal spraying, or some combination of treatments chosen for their efficiency.

Results

Deep hardwood litter proved to be an almost absolute barrier to seeding success. Matted leaves allowed few seeds to reach mineral soil, and excess leaves hindered seedling emergence. They also drifted over established seedlings and smothered or damaged them mechanically.

Seedbed preparation is necessary for direct-seeding success on the Cumberland Plateau and Highland Rim. Repellents to protect

A dense stand of Virginia pine was established by broadcasting seeds on an area that had been root-raked. Trees shown are 10 years old.

seeds from birds and rodents are also essential. There were no failures where properly prepared beds were sown with adequate numbers of repellent-coated seeds.

Loss of newly established seedlings to drought is a hazard in some regions, but in 7 years of direct seeding in central Tennessee, seedling mortality attributable to drought was never high enough to cause failure.

Broadcast Sowing

Study 1 tested disked sites and undisturbed hardwood litter; loblolly pine seed was sown in March 1957 at a rate of 15,000 sound seeds per acre. Study 2 included loblolly, shortleaf, and Virginia pine and tested disked, burned, and unprepared seedbeds. Plots were sown in December 1957 and in January and March 1958. Because of a wet fall, seedbeds could not be burned until January, and December sowing could not be tested on burns. The sowing rate was 14,000 per acre for all seedbeds and species. Unstratified seed was used in December and January; March-sown seed was stratified.

Studies 1 and 2 were on top of the Cumberland Plateau. Soils ranged from well-drained loams to sandy loams; depth to bedrock averaged about 2 feet. Existing stands contained low-grade oaks and hickories, along with an occasional blackgum, red maple, sourwood, or other miscellaneous species. They had a moderately dense

A bog disk pulled by a small tractor prepared seedbeds suitable for broadcast sowing but did not eliminate hardwood competition.

understory of small trees and shrubs. Hardwood litter was 2 to 6 inches deep and was underlain by a thin layer of unincorporated humus. Where well-developed, the litter and humus formed an almost continuous mat over the mineral soil.

Two or three passes with a medium-weight disk were needed to prepare a mineral-soil seedbed. Burning for study 2 was done in January. On most plots, up to 0.5 inch of partially decomposed leaves remained—a common result with winter fires on the Cumberland Plateau, where deep hardwood litter seldom dries until late spring.

Repellent-treated seed generally yielded higher initial seedling catches, although fairly good stands were sometimes obtained with untreated seed (table 2). Plots sown with repellent-coated and untreated seed were intermingled closely. This design probably ruled out a rigorous test of repellents, because the effects of endrin on small mammals may have extended over all plots. Even so, seed protection significantly increased overall seedling establishment in both study 1 and study 2.

For both seed treatments combined in study 1, disking significantly increased initial catch and first-summer survival of loblolly pine (table 2). Increased survival probably resulted mainly from the reduction of hardwood litter, although July and August 1957 were dry (table 3), and the partial control of small woody vegetation may have increased the supply of moisture to seedlings.

In study 2, seedbed preparation again significantly increased both seedling establishment and survival. Disking was not significantly superior to burning.

Data in table 2 are averaged over months of sowing because differences between months were usually small and less consistent than those caused by repellents or seedbed treatments. For individual species, initial seedling catches differed on the variously prepared seedbeds by month of sowing, but these interactions were not of practical importance. The most important and clear-cut indications of study 2 are the need for seedbed preparation and the similar responses of all pines tested to seedbed treatments.

Milacre stocking, as given in table 2, is a good measure of direct-seeding success. It integrates the results of both seedling establishment and first-summer survival. It ordinarily changes little during the next several years, and, in such diverse regions as the Missouri Ozarks and the Gulf Coastal Plain, enables seeding success or failure to be gauged by the end of the first growing season *(5, 7)*. In central

Only statistical significance at the 0.05 level or higher is reported in this paper.

Table 2.—*Broadcast seeding results on various seedbeds (studies 1 and 2)*

Study No.	Seed treatment and species	Initial seedling catch [1]			First-summer survival			Milacre stocking [2]		
		Disked	Burned	None	Disked	Burned	None	Disked	Burned	None
		Percent								
1	**Repellent treated**									
	Loblolly	59		5	77		50	97		27
	Untreated seed									
	Loblolly	31		5	68		70	71		27
	All treatments	45		5	72		60	84		27
[3] 2	**Repellent treated**									
	Loblolly	39	15	3	79	54	46	94	54	17
	Shortleaf	38	29	4	87	68	42	89	79	16
	Virginia pine	30	28	6	84	72	60	78	92	36
	All species	36	24	4	83	65	49	87	75	23
	Untreated seed									
	Loblolly	26	17	3	74	68	55	70	62	20
	Shortleaf	19	10	2	84	53	67	78	42	11
	Virginia pine	24	15	4	86	72	38	81	75	8
	All species	23	14	3	81	64	53	76	60	13
	All treatments	30	19	4	82	64	51	82	68	18

[1] Proportion of full seeds that produced a seedling during the first growing season.

[2] Proportion of sample milacres that contained one or more seedlings at the end of the first growing season.

[3] Data for December, January, and March sowing combined.

Tennessee some pine seeds may germinate the second year after sowing, but such germination is seldom enough to raise initially poor stocking to an acceptable level.

In both studies 1 and 2, significantly more uniform seedling distribution was obtained on prepared seedbeds than in undisturbed litter. Coating with repellents did not significantly improve stocking, but animal pressures may have been lighter than usual. Such for-

Table 3.—*Distribution of precipitation from April through October, 1957 through 1963* [1]

Year	Study No.	Rainfall	Growing season droughts [2]	
			Start	Duration
		Inches		*– Days –*
1957	1	32.26	June 30	36
			Aug. 19	22
1958	2	35.47	May 10	23
			Aug. 26	23
			Sept. 22	40
1959	3	32.94	May 31	25
			Sept. 12	25
1960	4	29.59	March 31	27
			May 9	39
			July 5	35
1961	5	31.23	July 18	23
			Sept. 2	31
			Oct. 4	28
1962	6	30.49	Apr. 13	47
			Aug. 17	31
1963	7	23.44	Sept. 30	32

[1] Data for 1957 through 1962 were collected at the weather station on the campus of the University of the South. Data for 1963 are from Centerville, Tennessee, substation, 8 miles northeast of the study 7 area.

[2] Periods of 3 weeks or longer during which no single rain exceeded 0.5 inch.

tunate results with unprotected seed have proved to be the exception in large-scale operations.

Study 3 included loblolly, shortleaf, and Virginia pine on separate, adjacent study areas. Seedbeds were undisturbed, burned, or burned and scarified by raking. The last treatment is admittedly impractical, and was intended to help define the efficiency of burned seedbeds by providing exposed mineral soil for comparison. Litter was interspersed with herbaceous vegetation, especially on the area seeded with Virginia pine. Plots were sown in March 1959 at rates of 10,000 stratified full seeds per acre for all species.

The study area lies below the sandstone escarpment of the Cumberland Plateau. It is underlain with limestone, and about 50 percent of the surface is covered by boulders and outcrops. The site is dry. Timber on the area was mainly oak of small-sawtimber size, but largely unmerchantable. Associated species were hickories, blackgum, and eastern redcedar. Reproduction of these species, plus blackhaw and wild plum in openings, formed a light to moderately dense understory.

A June drought (table 3) contributed to generally poor catches, particularly for Virginia pine (table 4). Many germinating seedlings died before they were well established. Repellent-treated shortleaf pine seed proved significantly superior to untreated seed. Seedbed preparation significantly increased initial tree percents only for shortleaf pine.

Repellent-treated shortleaf seed yielded high stocking on scarified plots. Milacre stocking of loblolly was about 50 percent for both prepared seedbeds and for both seed treatments (table 4). Stocking obtained with all other species and seedbed treatments ranged downward from 43 percent.

Table 4.—*Effects of seedbeds and repellent treatments on success with three species on a rocky slope (study 3)*

Species and seed treatment	Initial seedling catch [1]			First-summer survival			Milacre stocking [2]		
	Scarified	Burned	None	Scarified	Burned	None	Scarified	Burned	None
	Percent								
Loblolly									
Repellent treated	18	11	0	87	84	. .	57	47	0
Untreated seed	11	14	3	84	93	87	50	57	17
All treatments	14	12	2	86	88	87	54	52	8
Shortleaf									
Repellent treated	32	9	5	71	39	43	83	30	13
Untreated seed	13	7	5	47	45	33	33	27	3
All treatments	22	8	5	59	42	38	58	28	8
Virginia pine									
Repellent treated	9	9	3	43	61	67	23	27	10
Untreated seed	7	12	4	48	89	33	13	43	10
All treatments	8	10	4	46	75	50	18	35	10

[1] Proportion of full seeds that produced seedlings during the first growing season.

[2] Proportion of sample milacres that contained one or more seedlings at the end of the first growing season.

The marginal success obtained with some treatments resulted mainly from low initial seedling catches. Survival of all species was adequate on prepared seedbeds, indicating that satisfactory stands would have been obtained if enough seed had been sown. Study 3 demonstrated the risks inherent in direct-seeding pine on marginal sites. On dry, rocky sites, 10,000 broadcast seeds per acre are too few, even in the relatively favorable climate of the Cumberland Plateau.

Furrow Seeding

Furrow seeding (study 4) proved feasible on typical Cumberland Plateau sites, even though the machine used was not specifically designed to operate in heavy timber and deep hardwood litter.

Loblolly, shortleaf, and Virginia pine were seeded on adjacent areas. For each species, sowing in mid-March with unstratified seed was compared with late-April sowing with stratified seed. The study area had a dense stand of pole-size hardwoods plus a few large trees, but the understory was fairly open. The same species were found here as on other plateau-top study areas.

Seeding was done with an early model H-C furrow seeder *(1)* attached to a fireplow. The machine drops seeds in a plowed furrow at a selected rate and presses them into the soil with a rubber packing wheel. This seeder, in various adaptations, has been used more in the South than any other. Plots were sown with two seeds per 18 inches of furrow (7,260 seeds per acre for furrows spaced 8 feet on centers).

March sowing of shortleaf pine yielded significantly higher tree percents than April sowing. Loblolly catches were equally mediocre for both months (table 5). First-summer survival of established seedlings of all species averaged 91 percent on March-sown furrows and 81 percent on furrows seeded in April. Stocking of all species at the

Table 5.—*Furrow-seeding results (study 4)*

Species and date of seeding	Initial seedling catch [1]	First-summer survival	Stocking [2]
		– – – Percent – – –	
Loblolly			
March—dry seed	20	84	65
April—stratified	19	80	48
Shortleaf			
March—dry seed	34	94	82
April—stratified	10	87	40
Virginia pine			
March—dry seed	39	94	82
April—stratified	22	77	58

[1] Proportion of full seeds that produced a seedling during the first growing season.

[2] Proportion of 6-foot furrow segments that had one or more seedlings at the end of the first growing season.

end of the first growing season was more uniformly distributed on furrows seeded in March. Significantly poorer stocking was obtained with April seeding of Virginia and shortleaf, but not of loblolly pine.

Although rabbits nipped 56 percent of the seedlings during the winter after seeding, they caused little mortality. Frost heaving destroyed many seedlings, however, and by May 1961 stocking had dropped to about 75 percent for shortleaf and Virginia pine on furrows seeded in March 1960. Loblolly stocking was reduced to 52 percent. On furrows seeded in April, winter mortality reduced stocking to 32 percent for loblolly and shortleaf and 45 percent for Virginia pine.

In operating the seeder, it was difficult to control plowing depth, and furrows were generally deeper than desirable. Severe losses were caused by removal of the surface soil and placement of seeds in the heavier subsoil, which is more susceptible to frost action. New machines that are designed to scrape away only enough material to expose mineral soil will reduce the hazard from frost heaving *(8)*.

H-C seeder on a typical site on the Cumberland Plateau. Although results were satisfactory, they would have been better if the furrows had been shallower.

Spot Seeding

Spot seeding is potentially well adapted to small or odd-shaped tracts, but deep litter on most plateau sites limits its use. Studies 5 and 6 evaluated the effects of sowing date, stratification, and hardwood litter on the efficiency of spot seeding. Preparing relatively large seedspots or deferring seeding until late spring reduced damage from drifting hardwood leaves. Burning to eliminate loose litter proved even more effective in increasing catches, survival, and stocking.

In study 5, spot seeding of loblolly pine in deep litter was tried in February, March, April, and May 1961. Study 6 tested spot seeding of loblolly pine in April 1962 in hardwood litter and on recently burned plots. Two sizes of seedspots were compared at all dates in 1961 and on both seedbeds in 1962. Both unstratified and stratified seeds were also tested for all dates, spot sizes, and seedbed treatments.

Small seedspots were made 1 to 2 inches wide with a spot seeder, which had a 1-inch-wide hook for scratching through litter to mineral soil. Seeds were dispensed automatically. Large spots were made with a four-toothed fire rake blade, which was attached to the seeder. On large spots, mineral soil was bared over a circular area about 12 inches in diameter, and leaves were raked away from the edges and scattered. Sowing rates averaged seven seeds per spot in study 5, and nine in study 6. Seeds were pressed into mineral soil but were not covered.

In study 5, for all dates and both seed treatments, large spots had significantly higher tree percents than small spots (table 6). Initial tree percents also increased progressively with lateness of sowing date, averaging 6 in February, 17 in March, 19 in April, and 26 in May. Statistical tests showed that:

(a) March was superior to February for seeding.

(b) April was better than February and March.

(c) May was superior to the preceding 3 months.

Tree percents averaged 29 on burned and 19 on unburned plots in 1962. Both burning and enlarging seedspots significantly boosted tree percents in that year.

For spots of both sizes in study 5, better seedling establishment was obtained with unstratified seed in February, but with stratified seed in all later months. This interaction of presowing seed treament with time of sowing was significant, and conforms to germination patterns usually expected with direct-seeded loblolly.

Table 6.—*Influence of seedbed, seed treatments, and month of sowing on spot seeded loblolly pine (studies 5 and 6)*

Study No.	Seedbed, month of sowing, and seed treatment	Initial seedling catch [1]		First-summer survival		Seedspot stocking [2]	
		Large	Small	Large	Small	Large	Small
		Percent					
5	**Unburned seedbeds**						
	February—stratified	6	2	51	33	13	3
	—dry seed	10	6	39	21	23	10
	March—stratified	22	19	23	13	25	10
	—dry seed	17	11	26	18	23	13
	April—stratified	31	13	33	27	38	18
	—dry seed	24	9	63	26	58	15
	May—stratified	35	26	59	30	72	37
	—dry seed	26	16	42	35	57	27
	Average	21	13	42	25	39	17
6	**Unburned seedbeds**						
	April—stratified	20	13	51	34	47	27
	—dry seed	27	15	51	46	56	33
	Burned seedbeds						
	April—stratified	28	20	84	74	71	66
	—dry seed	36	33	83	75	78	77
	Average	28	20	67	57	63	51

[1] Expressed as tree percents, based on average number of full seeds sown per spot.

[2] Proportion of spots having one or more surviving seedlings after one growing season.

Over both spot sizes and seedbeds in study 6, seedling catches averaged 28 percent with unstratified seed and 20 percent with stratified seed. The difference was statistically significant. Ordinarily, higher tree percents would be expected from stratified seed sown in April on the Cumberland Plateau, but May 1962 was the hottest since 1896 and the driest since 1951 *(12)*. Many of the preconditioned seeds started to germinate soon after sowing but died from excess heat or lack of moisture.

An average of 34 percent of the seedlings established in study 5 survived through the first growing season. This is low for pine on the Cumberland Plateau, especially since early summer rainfall was well distributed in 1961. July and August were dry, but droughts are generally considered to be less damaging in late summer than in spring or early summer. Enlarging seedspots significantly boosted first-summer survival in study 5, and burning increased seedling survival from 46 to 79 percent in study 6.

Most of the losses in both studies were caused by clipping of newly germinated pines. Small ants fed on a few seedlings, but

most damage was typical of that of small mammals, probably white-footed mice *(Peromyscus* spp.). Attacks were most frequent in spring; they tapered off by midsummer. Clipping was heaviest on unburned plots in 1962.

Enlarging the seedspots significantly increased stocking percents in study 5 (table 6). Stocking also increased progressively with deferred seeding, averaging 12 percent for February, 18 percent for March, 32 percent for April, and 48 percent for May. Seed stratification did not significantly affect stocking in either study.

In study 6, 73 percent of the seedspots on burned plots had one or more seedlings at the end of the 1962 growing season. On unburned plots, first-year stocking was significantly poorer—41 percent.

Rabbits destroyed almost 50 percent of the loblolly seedlings in study 6 during the first winter after seeding—the only instance in this series of studies where animals caused serious winter mortality.

Comparison of Spot and Broadcast Sowing

In study 7, excellent loblolly and Virginia pine stands were established on Tennessee's western Highland Rim both by spot and broadcast sowing. On the steep, chert-strewn slopes which were seeded, spotting was three times as effective as broadcasting in terms of initial tree percents.

Soils on the study area are silt loams originating from cherty limestone residuum. Pole-size oak and hickory of very poor quality and slow growth formed a dense cover before treatment.

The area was burned by a wildfire in August 1962, during an extended drought. Litter was consumed completely, and most of the hardwoods were top-killed. At the time of seeding, 20 percent of the area was covered with scattered windrows of leaves from hardwoods that had survived the fire. In broadcasting, plots were sown with stratified seed in April 1963 at a rate of 10,000 full seeds per acre. An unmodified spot seeder was used to sow 1,000 seedspots per acre with five seeds on each spot.

A higher proportion of seeds produced a seedling when they were spotted than when they were broadcast (table 7). Slightly better average stocking for all species was obtained by spot seeding. Loblolly stocking at the end of the first growing season was about equally good for both seeding methods. Poorer distribution of Virginia pine on broadcast-sown plots may have resulted from washing of the small seeds before and during germination. Few seeds of either species were displaced from spots.

Table 7.—*Success of spot and broadcast seeding by species (study 7)*

Species	Initial catch [1]		Stocking [2]	
	Broadcast	Seedspots	Broadcast	Seedspots
	Percent			
Loblolly	17	45	75	78
Virginia pine	19	63	69	95
Mean	18	54	72	86

[1] Proportion of the seeds sown that produced a seedling during the first growing season.

[2] Proportion of sample milacres or of seedspots having one or more seedlings at the end of the first growing season.

Broadcast sowing required 10,000 loblolly seeds per acre to achieve about the same stocking as that obtained with 5,000 seeds on prepared spots. With Virginia pine, spot seeding decreased the number of seeds required to obtain a given stocking by more than 50 percent.

First-summer survival was better than 90 percent for both species. Rabbits lightly browsed 15 percent of the young pines during the winter of 1963-64, but 99 percent of the seedlings were still living the following spring.

An earlier exploratory test on the narrow ridges of the Highland Rim showed that loblolly, shortleaf, or Virginia pine could be established by broadcasting repellent-treated seed on disked beds *(9)*. This conclusion has been confirmed in commercial operations where hardwood stands have been cleared mechanically and direct-seeded successfully. Spotting saves seed and usually yields higher stocking because of regular spacing, but it requires more labor than broadcasting.

Recommendations

Direct seeding is practical for converting low-grade hardwood stands on the Cumberland Plateau and Highland Rim to loblolly, shortleaf, or Virginia pine. Studies not described in the present paper show that eastern white pine can also be established in the region by the procedures recommended *(3, 10)*.

The climate in the southern highlands favors good germination, and, provided hardwoods are controlled, good pine seedling survival can be expected. Leaf litter builds up more in the uplands than farther south, and hardwoods are generally more vigorous and more dense than in the regions where pine direct seeding was first developed. Control of unwanted hardwoods is a formidable problem

Eastern white pine 8 years after seeding on disked site. The original stand of hardwoods was deadened by injecting the trees.

on many sites in central Tennessee, but it is one that must be overcome whether one direct seeds or plants.

The key requirements for successful pine seeding are:

(1) Suitable seedbeds

(2) Protection of seeds from birds and rodents

(3) Sufficient sound seeds sown at the right time

(4) Release of seedlings from overtopping hardwoods.

Requirements are about the same for loblolly, shortleaf, and Virginia pine.

Seedbed Preparation

For broadcast sowing, moist mineral soil must be exposed. Light disking worked well in the present studies but is too expensive for seedbed preparation alone on hardwood-dominated sites. Mechanical site treatments should be employed primarily to reduce competition. Any mechanical treatment thorough enough to control hardwoods will provide an excellent seedbed as a secondary benefit. Bulldozing

and heavy disking have satisfactorily controlled hardwoods on the plateau *(11)*. Rolling choppers, K-G blades, or other equipment can be used where conditions permit. Treatment during the growing season will give better control with less resprouting than that done when hardwoods are dormant. If sites must be prepared in the fall or winter, they should be allowed to settle for at least 2 months before sowing, to minimize losses from washing and silting.

Open stands of hardwoods can be eliminated economically with single-stem treatments. Seedbeds should be burned to reduce heavy litter.

Where hardwoods are to be controlled by mass chemical treatments before seeding, litter must still be reduced to expose sufficient mineral soil. Fire is recommended as the easiest and cheapest method. Fire can also be used where hardwoods are killed by single-stem treatments. Where steep slopes or rocky soils rule out mechanical site preparation, burning is the only practical way to eliminate deep litter. Of course, it should be avoided where excessive erosion

will result. Winter or spring fires may give only fair seedbeds unless lower layers of litter are dry. Where burns are spotty, sowing rates should be increased to compensate for incompletely prepared seedbeds. Dormant-season burns do not adequately control hardwoods in the region and may cause considerable sprouting *(14)*. Where sites are not cleared mechanically and burning is relied on for seedbed preparation, the remaining hardwoods must subsequently be controlled.

Even when seeds are placed directly on mineral soil, deep hardwood litter can cause failure. It is, therefore, best to burn sites that have deep and matted hardwood litter, even when spot seeding. Where fire cannot be used, carefully preparing large seedspots and deferring seeding until late spring will improve chances for success.

Burning deep hardwood litter before furrow seeding is standard practice *(1)*, and is recommended. Burns for spot or furrow seeding need not completely reduce litter, since the goal is to remove only loose leaves that might cover seeds.

For the shallow surface soils common in Tennessee, furrow seeders should be designed and adjusted to cut only deep enough to expose mineral soil. Seeding in deep furrows increases risk of frost heaving, not only in the year of seeding but during the following winter.

Protecting Seed

All pine seeds must be treated with an effective repellent to prevent excessive losses to birds, small mammals, and insects. Repellents are essential on most areas and are cheap insurance even where heavy animal pressures are not expected. A powdered Arasan and endrin formulation was used in the studies reported, but an improved repellent containing Arasan 42-S (a liquid thiram suspension) is now recommended for all pine direct seeding throughout the South *(2)*.

Sowing Rates and Dates

On the Cumberland Plateau and Highland Rim, 10,000 sound seeds per acre are adequate for broadcasting on favorable sites, provided that seedbeds are well prepared. On less favorable sites or where seedbeds are less than optimum, the number should be increased to as many as 20,000 seeds per acre. The exact number will vary, depending on site and seedbed conditions. It is better to seed at a relatively high rate in initial trials than to risk failure because of insufficient seed. Sowing rates can be gradually reduced as experience is gained and requirements for specific sites are determined.

Furrow seeding requires one seed per 9 to 12 inches of furrow. Seedspots should contain at least five seeds, and more than five if a high proportion of the seed is empty or if potential for germination is poor. For any seeding method, however, it is inadvisable to use seed that has less than 70 percent germinability (on a sound seed basis), because poor germination may indicate low vigor.

The relatively favorable climate of the Tennessee highlands permits more latitude in choosing sowing dates than further south. Good germination and stocking were obtained in various studies with seed sown from December through May. A few landowners and foresters in the highlands have seeded over an even longer period. The research at Sewanee did not indicate that any particular month was optimum. The period from mid-March through April is usually likely to be followed by favorable weather, and probably should be preferred. Broadcasting can be done over a somewhat longer season with little risk. Seeding earlier than December or later than May in central Tennessee may increase risks appreciably, however. Spot seeding in hardwood litter should be deferred as late in the spring as is consistent with obtaining good germination.

Stratified pine seeds should be sown in the spring; in late winter, dry seeds should be used. On the Cumberland Plateau and Highland Rim, the change from dry to stratified seeds should be made from 2 to 4 weeks before the average date of the last killing frost in the spring.

Control of Competition

Control of unwanted hardwoods is the most difficult and expensive part of type conversion. The method chosen and its cost depend on the site and on the existing stand. Dense stands of small hardwoods, which are particularly prevalent on the Cumberland Plateau, should be eliminated before seeding. Hardwood stands of small pole to sawtimber size, and with little understory, should be deadened by single-stem treatments immediately after an adequate catch of pine seedlings is obtained.

General Precautions

The foregoing recommendations deal only with key factors for successful direct seeding. They incorporate modifications in standard techniques that were indicated by research on the Cumberland Plateau and Highland Rim.

Previous research indicates that shortleaf and Virginia pine seeds should be obtained either from local stands or from stands growing in a climate similar to that of the highlands of Tennessee. Seeds from far warmer or colder climates are likely to produce slow-growing or

Hardwood understories must be eliminated before seeding or planting pine. Any mechanical treatment thorough enough to control this understory will also provide an adequate seedbed.

poorly formed trees *(13)*. Loblolly pine does not occur naturally in a climate as cold as that of the highlands, but trees from seeds collected in the northern part of its range have proved to be vigorous and frost-hardy on the Cumberland Plateau and Highland Rim *(6)*. Northern sources, therefore, are recommended.

Techniques for storing and treating seed, using and calibrating seeding tools, and planning and evaluating direct-seeding operations are very important, but methods are the same for the Tennessee highlands as elsewhere. Also common to all regions are the procedures for determining potential hazards from livestock, game animals, and minor predators, and for carrying out the necessary control measures. Landowners or foresters who are considering direct seeding and who are not familiar with recommended techniques are referred to the publications of Derr and Mann for further information *(2, 4, 5)*.

Its lower cost makes direct seeding an attractive alternative to planting as a means of establishing pine in the highlands of Tennessee. In this loblolly pine stand, which was seeded 11 years ago, both stocking and growth are adequate.

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Volume Tables and Point-Sampling Factors for LOBLOLLY PINES in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands

Glendon W. Smalley
David R. Bower

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director

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Volume Tables and Point-Sampling Factors for Loblolly Pines in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands

Glendon W. Smalley [1] and David R. Bower [2]

The tables and equations published here provide ways to estimate total and merchantable cubic-foot volumes, both inside and outside bark, of loblolly pines *(Pinus taeda* L.) planted on abandoned fields in the Ridge and Valley, Cumberland Plateau, Eastern Highland Rim, and Western Highland Rim regions of Tennessee, Alabama, and Georgia (fig. 1). There already are about 300,000 acres of loblolly plantations on such sites, and more are likely to be established. The tables and equations should prove useful in growth and yield studies, forest inventories, timber sales, and management plans.

Basic data were obtained by felling and measuring a total of 340 trees at points throughout the four physiographic regions. Tree ages ranged from 10 to 31 years.

Similar tables are available for shortleaf pine *(4).*[3]

Study Methods

All sample trees were cut off 3 inches above ground on the uphill side. Total height (H) was measured to the nearest foot from ground level on the uphill side to the tip. Forked or other deformed trees were avoided. Additional measurements included diameter outside bark and inside bark at stump height, at breast height (D), and at maximum intervals of 5 feet to tops of 4.0, 3.0, and 2.0 inches o.b. For the tables, the minimum tree considered in each utilization class was 5.0 inches o.b. at breast height. Thus, the tables are based on data from 196 trees; number of stems measured in each diameter-height category is indicated in table 1. Separate equations were fitted, however, for a larger sample that included 144 stems less than 5.0 inches d.b.h.

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[1] Soil Scientist, stationed at the Silviculture Laboratory, maintained at Sewanee, Tennessee, by the Southern Forest Experiment Station in cooperation with the University of the South.

[2] Statistician, Southern Forest Experiment Station, New Orleans, Louisiana.

[3] Italic numbers in parentheses refer to Literature Cited, p. 5.

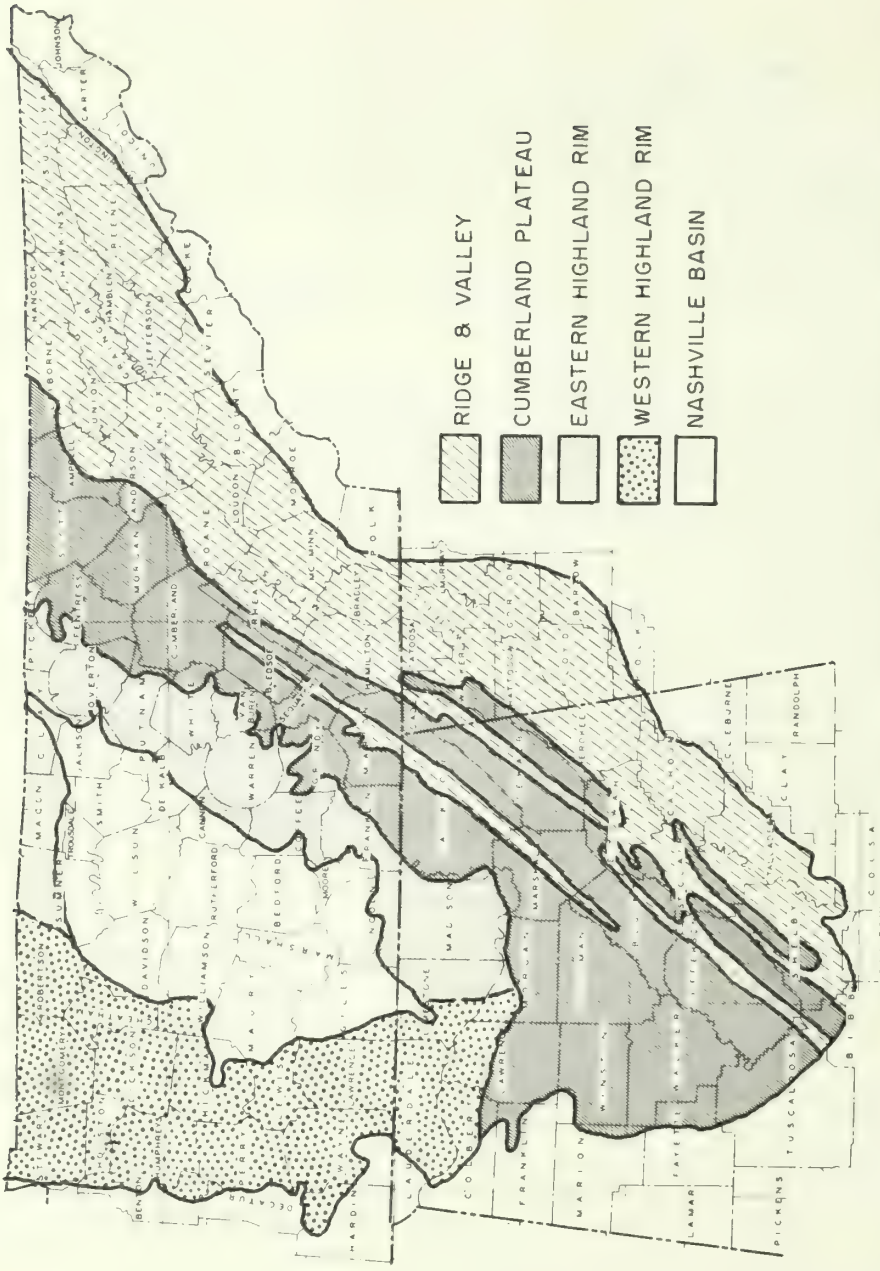

Figure 1.—*Physiographic regions of middle Tennessee, north Alabama, and northwest Georgia.*

Cubic volume of each tree was computed by Smalian's formula. Volumes in the 3-inch stumps were excluded.

Predicting equations were determined by regression analysis using a stepwise fit of volume on D, D^2, D^3, H, DH, D^2H, H/D, log D^2H, height to live crown, and ratio of height to live crown over H,

for eight volume categories (i. e., volumes inside and outside bark to four heights). Many functions fitted the data well as judged by high R^2 values, but multiple regressions added little to the R^2 values beyond that achieved by relating volume to D^2H alone.

Heterogeneous variance of volume made it necessary to apply a weighting procedure. For various threshold diameters, three statistical weights were tested: unity, the inverse of D^2H, and the inverse of $(D^2H)^2$. By Furnival's index of fit *(2)* there was little difference in efficiency between the inverse of D^2H and the inverse of $(D^2H)^2$. The latter was chosen, as it minimized problems of intersection. The volume tables were therefore derived from weighted linear regressions of the form:

$$V(D^2H)^{-1} = b_1 + b_0(D^2H)^{-1}$$

where

V = gross volume in the appropriate units

D = diameter at breast height, outside bark, in inches

H = total height in feet

b_0, b_1 = regression constants

Fitting the equation by ordinary least squares is the same as weighting the squared residuals of $V = b_0 + b_1D^2H$ by $1/(D^2H)^2$.

A covariance analysis of regressions for total cubic-foot volume outside bark showed no differences, at the 0.01 level of significance, between physiographic regions in either slope or intercept values. The data were therefore combined for computing the values in tables 1, 3, 5, 7, 9, 11, 13, and 15. The equation, the geometric mean of D^2H, and the standard error of estimate are shown below each table.

Tables 2, 4, 6, 8, 10, 12, 14, and 16 give point-sampling factors for each combination of tree diameter and height appearing in the corresponding volume table. Volumes per square foot of basal area were derived by dividing each volume equation by $0.005454D^2$, a formula for basal area.

In all tables, midpoints of the total height classes are multiples of 5 feet, e.g., 30 = 28 through 32 feet. The midpoint of each diameter class is given, e.g., 7 = 6.5 through 7.4 inches. The boxed portion of each volume table indicates the extent of basic data.

Using the Tables and Equations

The volumes and point-sampling factors in the tables should prove applicable throughout the area indicated in figure 1. For developing the equations on which the tables were based, tree diameters were measured to tenths of an inch and heights were

measured to the nearest foot. The same limits of accuracy are recommended in application of the tables or equations.

A point-sampling cruise may be made by measuring diameters and heights of trees counted through a prism or relascope and applying the volume-conversion factors from the even-numbered tables. Volume per acre is computed as follows:

1. Multiply the number of counted trees in each diameter-height class by the point-sampling factor for the class.
2. Sum the products of step one.
3. Multiply the total of step two by the basal area factor of the prism or other angle gage used.
4. Divide the product of step three by the number of points sampled in the plantation.

If a sampling error for the overall average volume per acre is desired, individual point estimates of volume per acre must be calculated, i.e., the tally of each point must be kept separate. Instructions can be found in Beers and Miller *(1)* or Hunt, Baker, and Biskamp *(3)*.

When maximum precision and accuracy are desired, volumes should be computed from the equations rather than read from the tables. For a conventional cruise of trees larger than 5.0 inches d.b.h., volumes for any combinations of diameters and heights can be obtained by summation of the appropriate equation. Thus, outside-bark volumes of entire stems would be obtained by summing the equation for table 1 over n sample trees:

$$\Sigma V_c \text{ (o.b.)} = 0.0026109\ \Sigma D^2H + 0.1683(n)$$

For a point-sampling cruise the corresponding equation (table 2) would be:

$$\Sigma V_p \text{ (o.b.)} = BAF(0.4787(\Sigma H) + 30.8572(\Sigma D^{-2}))$$

Individual heights and reciprocals of squared diameters are accumulated over all trees for each sample point.

If the inventory includes trees smaller than 5.0 inches d.b.h., the following equations may be used for total tree volume:

$$V_c \text{ (o.b.)} = 0.02364 + 0.00274616(D^2H)$$
$$V_c \text{ (i.b)} = 0.01182 + 0.00199894(D^2H)$$

These two equations are not to be compared with those having a minimum-diameter threshold of 5.0 inches. Including smaller trees modifies the slope, so that these equations may intersect with the 5.0-inch equations within the range of sampled data.

The equations used to develop volumes for different top-utilization levels (and 5.0-inch threshold diameters) do not intersect one another within the range of diameters and heights given in the tables.

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Table 1.—*Outside-bark volume of entire stem* [1]

D.b.h., o.b. (inches)	Total height in feet												Basis: trees
	20	25	30	35	40	45	50	55	60	65	70	75	
	Cubic feet												*No.*
5	1.47	1.80	2.13	2.45	2.78	3.11	3.43	3.76	4.08				40
6		2.52	2.99	3.46	3.93	4.40	4.87	5.34	5.81	6.28			41
7		3.37	4.01	4.65	5.29	5.93	6.57	7.20	7.84	8.48	9.12		38
8			5.18	6.02	6.85	7.69	8.52	9.36	10.19	11.03	11.87		38
9				7.57	8.63	9.69	10.74	11.80	12.86	13.91	14.97		24
10						11.92	13.22	14.53	15.83	17.14	18.44	19.75	9
11							15.96	17.54	19.12	20.70	22.28	23.86	3
12								20.85	22.73	24.61	26.49	28.37	2
13									26.64	28.85	31.06	33.26	1
Basis: No. of trees	1	2	5	31	37	37	26	19	22	13	2	1	196

[1] Derived from $V = 0.0026109(D^2H) + 0.1683$. Geometric mean of $D^2H = 2.237$; standard error of estimate = 0.0002310 cu. ft. D^2H.

Table 2.—*Outside-bark volume of entire stem, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	10.8	13.2	15.6	18.0	20.4	22.8	25.2	27.6	30.0			
6		12.8	15.2	17.6	20.0	22.4	24.8	27.2	29.6	32.0		
7		12.6	15.0	17.4	19.8	22.2	24.6	27.0	29.4	31.7	34.1	
8			14.8	17.2	19.6	22.0	24.4	26.8	29.2	31.6	34.0	
9				17.1	19.5	21.9	24.3	26.7	29.1	31.5	33.9	
10						21.8	24.2	26.6	29.0	31.4	33.8	36.2
11							24.2	26.6	29.0	31.4	33.8	36.2
12								26.5	28.9	31.3	33.7	36.1
13									28.9	31.3	33.7	36.1

[1] Derived from $V/B.A. = 0.4787(H) + 30.8572/D^2$.

Table 3.—*Inside-bark volume of entire stem* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.96	1.22	1.48	1.74	2.00	2.26	2.52	2.77	3.03			
6		1.79	2.16	2.54	2.91	3.28	3.65	4.03	4.40	4.77		
7		2.46	2.97	3.48	3.99	4.49	5.00	5.51	6.01	6.52	7.03	
8			3.90	4.56	5.23	5.89	6.55	7.21	7.88	8.54	9.20	
9				5.80	6.63	7.47	8.31	9.15	9.99	10.83	11.66	
10						9.24	10.28	11.31	12.35	13.38	14.42	15.45
11							12.45	13.70	14.95	16.21	17.46	18.71
12								16.32	17.81	19.30	20.79	22.28
13									20.91	22.66	24.41	26.16

[1] Derived from $V = 0.0020695(D^2H) - 0.0709$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002424 cu. ft./D^2H.

Table 4.—*Inside-bark volume of entire stem, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	7.1	9.0	10.9	12.8	14.7	16.6	18.5	20.3	22.2			
6		9.1	11.0	12.9	14.8	16.7	18.6	20.5	22.4	24.3		
7		9.2	11.1	13.0	14.9	16.8	18.7	20.6	22.5	24.4	26.3	
8			11.2	13.1	15.0	16.9	18.8	20.7	22.6	24.5	26.4	
9				13.1	15.0	16.9	18.8	20.7	22.6	24.5	26.4	
10						16.9	18.8	20.7	22.6	24.5	26.4	28.3
11							18.9	20.8	22.7	24.6	26.5	28.3
12								20.8	22.7	24.6	26.5	28.4
13									22.7	24.6	26.5	28.4

[1] Derived from V/B. A. $= 0.3794(H) - 12.9993/D^2$.

Table 5.—*Outside-bark volume to a 2.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	1.41	1.74	2.06	2.39	2.72	3.04	3.37	3.69	4.02			
6		2.45	2.92	3.39	3.86	4.33	4.80	5.27	5.74	6.21		
7		3.30	3.94	4.58	5.22	5.86	6.50	7.14	7.78	8.42	9.06	
8			5.12	5.95	6.79	7.63	8.46	9.30	10.13	10.97	11.80	
9				7.51	8.57	9.62	10.68	11.74	12.80	13.85	14.91	
10						11.86	13.16	14.47	15.77	17.08	18.39	19.69
11							15.90	17.48	19.07	20.65	22.23	23.81
12								20.79	22.67	24.55	26.43	28.31
13									26.59	28.79	31.00	33.21

[1] Derived from $V = 0.0026118(D^2H) + 0.1034$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002341 cu. ft./D^2H.

Table 6.—*Outside-bark volume to a 2.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	10.3	12.7	15.1	17.5	19.9	22.3	24.7	27.1	29.5			
6		12.5	14.9	17.3	19.7	22.1	24.5	26.9	29.3	31.7		
7		12.4	14.8	17.1	19.5	21.9	24.3	26.7	29.1	31.5	33.9	
8			14.7	17.1	19.5	21.8	24.2	26.6	29.0	31.4	33.8	
9				17.0	19.4	21.8	24.2	26.6	29.0	31.4	33.8	
10						21.7	24.1	26.5	28.9	31.3	33.7	36.1
11							24.1	26.5	28.9	31.3	33.7	36.1
12								26.5	28.9	31.3	33.7	36.0
13									28.8	31.2	33.6	36.0

[1] Derived from $V/B.A. = 0.4789(H) + 18.9580/D^2$.

Table 7.—*Inside-bark volume to a 2.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.91	1.17	1.43	1.69	1.95	2.21	2.47	2.73	2.99			
6		1.74	2.12	2.49	2.86	3.23	3.61	3.98	4.35	4.72		
7		2.42	2.92	3.43	3.94	4.44	4.95	5.46	5.97	6.47	6.98	
8			3.85	4.52	5.18	5.84	6.50	7.17	7.83	8.49	9.15	
9				5.75	6.59	7.43	8.26	9.10	9.94	10.78	11.62	
10						9.20	10.23	11.27	12.30	13.34	14.37	15.41
11							12.40	13.66	14.91	16.16	17.41	18.67
12								16.28	17.77	19.26	20.75	22.24
13									20.87	22.62	24.37	26.12

[1] Derived from $V = 0.0020702(D^2H) - 0.1201$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002431 cu. ft./D^2H.

Table 8.—*Inside-bark volume to a 2.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	6.7	8.6	10.5	12.4	14.3	16.2	18.1	20.0	21.9			
6		8.9	10.8	12.7	14.6	16.5	18.4	20.3	22.2	24.1		
7		9.0	10.9	12.8	14.7	16.6	18.5	20.4	22.3	24.2	26.1	
8			11.0	12.9	14.8	16.7	18.6	20.5	22.4	24.3	26.2	
9				13.0	14.9	16.8	18.7	20.6	22.5	24.4	26.3	
10						16.9	18.8	20.7	22.6	24.5	26.3	28.2
11							18.8	20.7	22.6	24.5	26.4	28.3
12								20.7	22.6	24.5	26.4	28.3
13									22.6	24.5	26.4	28.3

[1] Derived from V/B. A. $= 0.3796(H) - 22.0199/D^2$.

Table 9.—*Outside-bark volume to a 3.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	1.21	1.54	1.87	2.19	2.52	2.85	3.18	3.51	3.84			
6		2.26	2.73	3.21	3.68	4.15	4.62	5.10	5.57	6.04		
7		3.11	3.76	4.40	5.04	5.69	6.33	6.97	7.62	8.26	8.91	
8			4.94	5.78	6.62	7.46	8.30	9.14	9.98	10.82	11.66	
9				7.34	8.41	9.47	10.53	11.60	12.66	13.73	14.79	
10						11.72	13.03	14.34	15.66	16.97	18.28	19.60
11							15.79	17.38	18.97	20.56	22.15	23.74
12								20.70	22.59	24.48	26.38	28.27
13									26.53	28.75	30.97	33.19

[1] Derived from $V = 0.0026271(D^2H) - 0.1051$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002536 cu. ft./D^2H.

Table 10.—*Outside-bark volume to a 3.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	8.9	11.3	13.7	16.1	18.5	20.9	23.3	25.7	28.1			
6		11.5	13.9	16.3	18.7	21.1	23.5	26.0	28.4	30.8		
7		11.6	14.1	16.5	18.9	21.3	23.7	26.1	28.5	30.9	33.3	
8			14.1	16.6	19.0	21.4	23.8	26.2	28.6	31.0	33.4	
9				16.6	19.0	21.4	23.8	26.3	28.7	31.1	33.5	
10						21.5	23.9	26.3	28.7	31.1	33.5	35.9
11							23.9	26.3	28.7	31.1	33.6	36.0
12								26.4	28.8	31.2	33.6	36.0
13									28.8	31.2	33.6	36.0

[1] Derived from $V/B.A. = 0.4817(H) - 19.2697/D^2$.

Table 11.—*Inside-bark volume to a 3.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.76	1.02	1.28	1.54	1.80	2.06	2.32	2.58	2.84			
6		1.59	1.97	2.34	2.72	3.09	3.47	3.84	4.22	4.59		
7		2.27	2.78	3.29	3.80	4.31	4.82	5.33	5.84	6.35	6.86	
8			3.72	4.38	5.05	5.72	6.38	7.05	7.71	8.38	9.05	
9				5.62	6.46	7.31	8.15	8.99	9.84	10.68	11.52	
10						9.09	10.13	11.17	12.21	13.25	14.29	15.33
11							12.32	13.58	14.83	16.09	17.35	18.61
12								16.21	17.71	19.21	20.71	22.21
13									20.83	22.59	24.35	26.11

[1] Derived from $V = 0.0020821(D^2H) - 0.2811$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002524 cu. ft./D^2H.

Table 12.—*Inside-bark volume to a 3.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	5.6	7.5	9.4	11.3	13.2	15.1	17.0	18.9	20.8			
6		8.1	10.0	11.9	13.8	15.7	17.7	19.6	21.5	23.4		
7		8.5	10.4	12.3	14.2	16.1	18.0	19.9	21.9	23.8	25.7	
8			10.6	12.6	14.5	16.4	18.3	20.2	22.1	24.0	25.9	
9				12.7	14.6	16.5	18.5	20.4	22.3	24.2	26.1	
10						16.7	18.6	20.5	22.4	24.3	26.2	28.1
11							18.7	20.6	22.5	24.4	26.3	28.2
12								20.6	22.5	24.5	26.4	28.3
13									22.6	24.5	26.4	28.3

[1] Derived from V, B. A. $= 0.3817(H) - 51.5387/D^2$.

Table 13.—*Outside-bark volume to a 4.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.73	1.06	1.39	1.73	2.06	2.39	2.72	3.06	3.39			
6		1.79	2.27	2.75	3.23	3.71	4.19	4.67	5.15	5.63		
7		2.66	3.31	3.96	4.62	5.27	5.92	6.57	7.23	7.88	8.53	
8			4.51	5.36	6.21	7.07	7.92	8.77	9.62	10.48	11.33	
9				6.95	8.03	9.10	10.18	11.26	12.34	13.42	14.50	
10						11.38	12.71	14.05	15.38	16.71	18.04	19.37
11							15.51	17.12	18.73	20.35	21.96	23.57
12								20.49	22.41	24.33	26.25	28.16
13									26.41	28.66	30.91	33.16

[1] Derived from $V = 0.0026638(D^2H) - 0.6054$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0003005 cu. ft./D^2H.

Table 14.—*Outside-bark volume to a 4.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	5.3	7.8	10.2	12.7	15.1	17.5	20.0	22.4	24.9			
6		9.1	11.6	14.0	16.5	18.9	21.3	23.8	26.2	28.7		
7		9.9	12.4	14.8	17.3	19.7	22.2	24.6	27.0	29.5	31.9	
8			12.9	15.4	17.8	20.2	22.7	25.1	27.6	30.0	32.5	
9				15.7	18.2	20.6	23.0	25.5	27.9	30.4	32.8	
10						20.9	23.3	25.8	28.2	30.6	33.1	35.5
11							23.5	25.9	28.4	30.8	33.3	35.7
12								26.1	28.5	31.0	33.4	35.9
13									28.6	31.1	33.5	36.0

[1] Derived from $V/B.A. = 0.4884(H) - 110.9980/D^2$.

Table 15.—*Inside-bark volume to a 4.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.39	0.66	0.92	1.18	1.45	1.71	1.97	2.24	2.50			
6		1.24	1.62	1.99	2.37	2.75	3.13	3.51	3.89	4.27		
7		1.92	2.44	2.95	3.47	3.98	4.50	5.02	5.53	6.05	6.56	
8			3.38	4.06	4.73	5.41	6.08	6.75	7.43	8.10	8.78	
9				5.31	6.16	7.02	7.87	8.72	9.58	10.43	11.28	
10						8.82	9.87	10.92	11.98	13.03	14.08	15.14
11							12.08	13.36	14.63	15.90	17.18	18.45
12								16.02	17.54	19.05	20.57	22.09
13									20.70	22.47	24.25	26.03

[1] Derived from $V = 0.0021059(D^2H) - 0.6586$. Geometric mean of $D^2H = 2{,}237$; standard error of estimate = 0.0002775 cu. ft./D^2H.

Table 16.—*Inside-bark volume to a 4.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	2.9	4.8	6.8	8.7	10.6	12.5	14.5	16.4	18.3			
6		6.3	8.2	10.2	12.1	14.0	16.0	17.9	19.8	21.7		
7		7.2	9.1	11.0	13.0	14.9	16.8	18.8	20.7	22.6	24.6	
8			9.7	11.6	13.6	15.5	17.4	19.3	21.3	23.2	25.1	
9				12.0	14.0	15.9	17.8	19.7	21.7	23.6	25.5	
10						16.2	18.1	20.0	22.0	23.9	25.8	27.8
11							18.3	20.2	22.2	24.1	26.0	28.0
12								20.4	22.3	24.3	26.2	28.1
13									22.5	24.4	26.3	28.2

[1] Derived from $V/B.A. = 0.3861(H) - 120.7521/D^2$.

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FACTORS INFLUENCING NORTH CAROLINA LANDOWNERS TO PRACTICE FORESTRY

Walter C. Anderson

SOUTHERN FOREST EXPERIMENT STATION
T. C. NELSON, DIRECTOR

FOREST SERVICE
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Private nonindustrial owners are the least willing of all groups of landowners to practice forestry *(8,* p. 104).[1] Their lack of performance is of considerable concern. While the individual tracts are small, in the aggregate they comprise nearly three-fourths of the South's woodlands. Of three ways these forests could be placed under intensive management—acquisition, regulation, and persuasion —only persuasion has been tried extensively. Both public and private agencies have conducted programs of education, technical aid, and financial assistance to encourage these so-called small owners.[2] Those concerned with timber production from a public viewpoint concede, however, that such persuasive efforts have been largely unsuccessful. The reasons that these attempts failed cannot be fully understood nor can effective new programs be designed until knowledge concerning landowners' adoption of forestry has been expanded.

Previous investigations have described characteristics and behavior of southern forest owners, and identified attributes which differentiated those who practiced forestry from those who did not *(1, 5, 6).* The principal objective of the study reported here was to uncover the factors that influenced owners' adoption of forestry. Unlike that for earlier studies, the population was limited to owners who had practiced forestry, and the adoption of individual kinds of practices was investigated.

METHOD

The study was made in North Carolina. The landowners interviewed were among those whom the American Forestry Association (AFA), in a previous study, had found to be practicing forestry *(7).* The AFA's survey had been extensive, employing a sample of 4,698

[1] Italic numbers in parentheses refer to Literature Cited, p. 17.

[2] Among educational programs have been demonstrations, workshops, field days, visual displays, and the distribution of informational materials. In addition, tree seedlings for planting have been given away or sold at low cost, and technical aid from foresters has been provided to timber owners in such forms as woodland management plans and timber marking services. Some public agencies have also helped to finance certain forestry practices on private lands.

owners randomly drawn from private forest owners listed on the tax rolls of the State's 100 counties. North Carolina had been selected for the AFA survey because "small private nonindustrial forest properties predominate" *(7)*. It was one of three States, each with unique forest landownership problems, in which the AFA conducted pilot studies. The first study *(3)* was made in California, a State where more than half of the land is in Federal ownership. The second *(2)* was in Minnesota, where county and State holdings of forest land predominate as a consequence of past tax forfeitures.

Four-fifths of the commercial forest land in North Carolina is held in relatively small parcels by farmers and other nonindustrial private owners *(7)*. This general ownership pattern prevails throughout the forest area of the Eastern United States.

The AFA reported that as of 1960 one-fourth of all nonindustrial landowners had instituted some type of forestry practice during their tenure *(7)*. Before the subsample for the present study was drawn from the AFA sample, the population was further limited in two dimensions. First, only ownerships with 10 to 500 acres of forest land were included. Second, a more restrictive definition of "practicing forestry" was applied than had been used by the AFA. Owners who did no more than provide protection were excluded. Fencing the forest, in the absence of positive efforts to grow timber, was primarily for the benefit of livestock. Firebreaks were often plowed by the State forest service without cost to the landowner. Also excluded were those persons whose only practice was to plant less than 5 acres of trees. With these restrictions, a subsample was drawn of 100 owners who had adopted some forestry measures.

Four physiographic provinces are usually recognized in North Carolina; the forest situation in these provinces has been described by Knight and McClure *(4)*. By expansion of the subsample, the distribution of adopters among the provinces was estimated to be:

Physiographic province	Percent of owners
Southern Coastal Plain	24
Northern Coastal Plain	13
Piedmont	41
Mountains	22
	100

Similarly, forest acreage distributions were estimated as:

Size class	Percent of owners
10 to 50 acres	53
50 to 150 acres	34
150 to 500 acres	13
	100

The smallest ownerships are concentrated in the Mountains and Piedmont, where tracts of 10 to 50 acres account for about 70 and 60 percent of the total, respectively. Medium ownerships are most common in the Southern Coastal Plain. They make up around 55 percent of all ownerships in that province. The Northern Coastal Plain contains the greatest proportion of large ownerships (one-fourth).

Each owner was interviewed to learn the details of his forestry practices, personal characteristics, use of public services and other contacts, and related factors. Cross tabulation was used to winnow out the economic and social factors that influenced owners to undertake various practices.

FORESTRY PRACTICES

Forestry practices installed by the interviewees were:

Planting trees.

Site preparation by removing vines, brush, or other vegetation either to permit the area to seed in naturally or to help planted seedlings get started.

Timber marking, by a forester, of trees to be removed.

Improvement cutting by killing or removing crooked, rotten, diseased, and other low-value trees.

Thinning out young trees where they were too dense.

Pruning lower limbs to enhance tree value.

Fencing the woods to keep out livestock.

Plowing firebreaks along the edge of the woods to keep out fire.

The extent to which each practice was carried out by owners is shown in table 1.

Sixty percent of the owners adopted more than one kind of practice. Although some practices were closely related, e.g., site preparation and planting, and timber marking and thinning, the majority of owners applied a variety of practices. When practices were grouped into three classes—stand establishment, stand improvement, and protection—more owners

Table 1.—*Proportion of owners by the kinds of forestry practices adopted*

Forestry practice	Percent of owners
Stand establishment	
Planting	70
Site preparation	15
Stand improvement	
Timber marking	38
Thinning	37
Improvement cutting	23
Pruning	15
Protection	
Plowing firebreaks	29
Fencing	7

were found to have practices in two or three categories than in only one.

Among measures other than protection, timber marking covered the most acres per owner. The median area for marking was 17 acres, for thinning 10 acres, and for planting 7 acres. The median area for other practices, except plowing firebreaks, was smaller. Half of those who plowed firebreaks protected 26 acres or more, but plowing was done only along forest perimeters.

Planting, the most common practice, was principally on open land. More than half the respondents planted crop and pasture land, a quarter cutover lands, and the remainder abandoned fields. Less than 15 percent planted in woodlands.

Prior to 1950, most owners limited their efforts to planting. Nearly a quarter planted for the first time during the 1930's and 1940's whereas less than 10 percent inaugurated any other practice. During these 2 decades, planting was the sole practice for which a strong public program existed.[3] Thereafter, all practices were subsidized to some extent.

Although subsidies for planting were widespread, the majority of owners still used their own labor in planting—only 35 percent hired the work done. Forty-five percent did the planting themselves or with the members of their families. Another 20 percent used farm labor. Also, three-fourths made a cash outlay for which they were not reimbursed, although the amount of money was fairly small—half spent less than $100. Of those who prepared sites before planting, 40 percent spent an additional $100 to $200 and 20 percent spent more.

Timber marking and thinning were the next most common practices. Owners' expenditures of money and time for these two practices were trival, although two-thirds of those who thinned had their timber marked. Marking service was provided free by the State forest service or a forest industry.

Nearly half the owners definitely planned to continue practicing forestry. Thirty-five percent had no future plans, and the remainder were undecided.

In all studies on record, owners who practiced forestry were compared with those who did not. This approach involved a conglomerate of owners inspired by widely differing motives and gave little basis for uncovering specific cause-and-effect relationships. To deal with more homogeneous groups of owners having similar

[3] The Clarke-McNary Act of 1924 provided for the distribution of tree seedlings to private landowners for planting. Sharing the cost of forest practices (primarily for tree planting) between the Government and individual landowners began in 1936 under the Agricultural Conservation Program.

objectives, the present study compared owners who undertook a specific practice with those who had not adopted the practice.

Planting and thinning appeared to be desirable practices for study. Opportunities for these two practices were widespread, and owners usually took advantage of them at an early stage in their adoption of forestry. The proportion of owners who reported these practices were:

Forest practices	Percent of owners
Planting	49
Thinning	16
Planting and thinning	21
Neither planting nor thinning	14
	100

Another advantage in selecting planting and thinning for study is that they are unrelated practices that can be carried out independently. Furthermore, they differ from each other economically in that planting requires a long-term investment while thinning usually involves disinvestment in timber capital.

More than 100 independent variables were screened for their relationship to planting and thinning. Among these were factors describing the forest ownerships, characteristics of the owners including indicators of their socioeconomic status, and the principal contacts through which owners received forestry and agricultural information. By relating each independent variable to these two practices, an initial attempt was made to determine which ones helped explain owners' adoption of planting and thinning. Those showing a relationship were examined further.

FOREST OWNERSHIPS

In each physiographic province, more than a third who practiced forestry planted and thinned, except that few in the Mountains did any thinning. However, thinning was mainly practiced in the Coastal Plain, and planting in the Piedmont:

Physiographic province	Percent of owners who—	
	Planted	Thinned
Southern Coastal Plain	46	59
Northern Coastal Plain	64	55
Piedmont	87	36
Mountains	71	4

Differences in the extent to which thinning was practiced in the four regions may be due in part to the tree species composition of the forests and the ownership patterns peculiar to each region.

Pine stands are the principal type requiring thinning. The proportion of pine volume in the forest declines from the eastern to the western part of the State, where hardwoods predominate. In the Coastal Plain, pines comprise more than 45 percent of the total cubic-foot volume; in the Piedmont 40 percent; and in the Mountains less than 20 percent *(4,* table 41).

Forest industry holdings, which often serve as examples of good forest management, are found predominantly in the Coastal Plain. Forest industries own one-fourth of all commercial timberland in the Northern Coastal Plain and one-sixth of the total in the Southern Coastal Plain *(4,* p. 3).

The frequency of planting in the Piedmont can be attributed partly to the agricultural adjustments underway there. Over the past 9 years, for example, farmer-owned forest in the Piedmont decreased by 1.7 million acres, an indication of the extent to which land is shifting out of agricultural ownership.[1] Most of this land is now held by people with nonfarm occupations, and thus much of it has become available for tree planting.

Both planting and thinning were positively related to size of forest ownership:

Forest acreage owned	Percent of owners who—	
	Planted	Thinned
10 to 50	67	28
50 to 150	72	46
150 to 500	82	48

In part, this relationship may reflect greater opportunities for forestry as tract size rises.

The value of real estate that owners reported ranged from a low of $3,000 to a high of $400,000. Those with holdings of $20,000 or less—53 percent of all respondents—planted more frequently than did owners with more valuable holdings. For thinning, the relationship was reversed.

Of all who practiced forestry, 45 percent owned idle or share-tenant farms, and 40 percent owned tenant farms of some kind or farms with "other" kinds of operators. The kinds of practices installed varied by the kind of farm operator (table 2). For share-tenant and idle farms, the proportion of owners who planted was above average. For all tenant farms, whether worked by share or cash tenants, the proportion of owners who thinned was above average. Owners of farms with "other" kinds of operators also thinned frequently.

[1] Source: Forest Survey Project, Southeast. Forest Exp. Sta., U. S. Forest Serv., Asheville, N. C.

Table 2.—*Proportions of owners planting and thinning, by kind of farm operator*

Farm operator	Number of owners	Percent of owners who—	
		Planted	Thinned
Farm is currently idle	27	76	16
Owner with no tenants	33	68	32
Share tenant	18	90	57
Cash tenant	12	59	56
Other	10	44	52
All	100	70	37

Of those who inherited all of their land, 90 percent planted; for those who had acquired their land by other means, 65 percent planted. Chief among the ways in which respondents obtained their forests, however, was purchase. Merely 20 percent acquired their tracts by inheritance only. Although an additional 22 percent also held land that had been in their family for generations, acquisition had involved purchase. Some had purchased family-owned lands; others had inherited family properties but then increased their acreage by buying land. The remaining 58 percent held lands that had never been in the family and had been acquired entirely by purchase.

Some variables that were thought important when the study was designed showed no association with landowners' adoption of planting or thinning. Among these were length of tenure, acres of land owned, acres of cropland operated, proportion of land in forest, and proportion of forest land outside the county and outside the State where the owner lived, expected eventual disposition of the land by the owner, and distance from the owner's home to his forest.

PROFILE OF OWNERS

The majority of owners who practiced forestry were rural residents. Eighty-five percent grew up on a farm; the same proportion lived on or near their forest properties which were either the place or near the place where they had grown up.

When owners' choices of practices were compared by occupation, 43 percent of the farmers and 32 percent of the nonfarmers were found to have thinned. For planting, the situation was reversed, the proportions being 65 and 76 percent. The principal owners who thinned, however, were those with "other" occupations, and the principal ones who planted were wage earners and clerical workers (table 3).

Table 3.—*Proportions of owners planting and thinning, by major occupation classes*

Major occupation	Number of owners	Percent of owners who—	
		Planted	Thinned
Farmer or retired farmer	45	65	43
Business or profession	30	69	20
Wage earner or clerk	13	100	8
Other [1]	12	70	82
All	100	70	37

[1] Chiefly housewives, widows, and retired nonfarmers.

Six attributes indicative of farm ownership or a farm background differentiated between those who adopted planting or thinning and those who did not (table 4). Some of these attributes are not obviously connected with farming. For example, farmers typically lack a minor occupation, i. e., they seldom work off the farm, while many nonfarmers do have a minor occupation, sometimes farming. Among owners with farmer-associated attributes, the proportion who thinned was greater than among those without these attributes. For planting the relationships were reversed.

Table 4.—*The relationship of farmer-associated attributes of owners to planting and thinning*

Farmer-associated attributes	Number of owners	Percent of owners who—	
		Planted	Thinned
Source of income			
All from farming	13	61	60
Some or all from nonfarm sources	87	71	33
Value of farm products sold annually			
$2,500 or more	35	60	58
Less than $2,500	35	74	35
No farm products sold	30	78	13
Minor occupation			
Farming	11	100	17
Other	14	31	17
None	75	64	43
Desire for farming advice			
Sought advice	60	69	41
Did not seek advice	40	72	29
Father's occupation			
Farming	75	60	41
Other	25	100	20
Membership in youth club			
Former member	29	60	50
Nonmember	71	73	31

Personal characteristics other than those connected with occupation also differentiated selectors and nonselectors of planting and thinning (table 5). In appraising the effect of economic status, the possession of individual items frequently included in level-of-living indexes were compared separately. While possessors of telephones planted and thinned less frequently than those without them, ownership of other items was positively associated with thinning but not with planting. Contrariwise, owners with incomes under $5,000

Table 5.—*The relationship of personal characteristics of owners to planting and thinning*

Personal characteristics of owners	Number of owners	Percent of owners who—	
		Planted	Thinned
Less than $5,000 annual income	57	69	45
More than $5,000 annual income	43	73	25
Has telephone	72	65	34
Does not have telephone	28	82	42
Has complete bathroom	83	66	37
Does not have complete bathroom	16	88	32
Has automatic washer	48	66	42
Does not have automatic washer	51	74	32
Has home freezer	58	67	42
Does not have home freezer	41	74	28
High school education or less	57	72	46
Education extended beyond high school	43	67	24
Younger than 40 years of age when first practiced forestry	26	57	44
40-60 years of age when first practiced forestry	49	76	38
Older than 60 years when first practiced forestry	25	74	26
Three or more sons	19	94	21
One or two sons	48	68	31
No sons	33	60	55
Children past high school age	63	82	33
No children past high school age	37	52	43
Children in grade school	25	55	49
No children in grade school	75	75	30
Children were youth club members	48	74	39
No children were youth club members	52	66	33
Children studied vocational agriculture	25	94	33
No children studied vocational agriculture	75	62	37

tended to thin. Those who thinned, by comparison with those who did not, tended to have children of grade school age, to have completed more years of formal education, and to have first practiced forestry when they were less than 40 years of age. Planters tended to be older than nonplanters when they first practiced forestry, to have more children, especially boys who had studied vocational agriculture, and to have children past high school age. Owners whose children belonged to a youth club both planted and thinned in greater numbers than those whose children were not club members.

Some personal characteristics of owners were also rejected as not influencing the selection of planting and thinning. Among these were the stage in the life cycle of the owner's family, and the condition in which he maintained his house and farmstead. Also, whether an owner attended college or received noncollege training beyond high school had no influence.

Imitation apparently played no part, since there was no difference between owners who knew others who practiced and those who did not. Further, those who knew others practicing forestry did not tend to follow the same practices. Neither was there any difference in the practices adopted by owners who went to agricultural agencies for information and those who relied on noninstitutional sources such as neighbors and friends.

Still other independent variables were discarded because nearly all observations fell in one stratum of the sample. Essentially all owners had electricity or running water in their houses, for example, and very few had children who carried out forestry practices.

PUBLIC FORESTRY PROGRAMS AND OTHER CONTACTS

Owners mentioned various communicative and noncommunicative sources of information as having influenced their decision to practice forestry. Sources of information were examined to determine which were associated with planting and which with thinning, and to what extent they were involved in the owners' decisions. Special attention was given direct attempts by the public to encourage the practice of forestry.

Of the many ways owners came into contact with forestry ideas, the most prevalent were mass media. More than a quarter of those who planted said they first became interested through reading newspapers and magazines. Although most owners also listened to farm programs on radio and television, these media had no discernible effect on the adoption of forestry practices.

Eighty percent of all owners read farm or forestry magazines. Of these readers, nearly 45 percent thinned; for nonreaders the percentage was less than 10.

Forty-three percent of the owners who practiced forestry held memberships in one or more agricultural organizations. These organizations were also an avenue through which owners could receive forestry information. Membership showed a positive relationship with thinning (53 to 25 percent), albeit a negative one with planting (45 to 91 percent).

Still another source of influence were the contacts owners made in connection with their farming activities. A quarter went to agricultural agencies, such as the Soil Conservation Service or a county agent, for advice before deciding to plant trees.

Owners who had received incentive payments for farming practices before they undertook forestry were more likely to have thinned than those who had received no payments or did not receive them until after they had first practiced forestry. Among the two groups, the proportions of owners who thinned were 46 and 22 percent, respectively.

It was expected that public forestry programs would be among the contacts strongly influencing the adoption of planting or thinning. The chief programs in which owners participated were forestry demonstrations, the Cooperative Forest Management (CFM) program, and the forestry sections of the Agricultural Conservation Program (ACP).

Nearly 40 percent of the owners who practiced forestry had attended a forestry demonstration, usually conducted by the State Extension Service. About a quarter of all owners attended before they practiced. Of these, a far smaller number planted than among the three-quarters who never attended a demonstration or did not attend until after they had practiced forestry: the respective proportions were 40 percent and 80 percent. The opposite situation existed with regard to thinning—42 percent of those attending demonstrations thinned as compared with 33 percent of those who never attended. Neither number of times demonstrations were attended nor whether attendance was before or after practicing forestry showed an effect on the proportion thinning, however. The extent to which demonstrations influenced the selection of forestry practices is inconclusive on the basis of this evidence.

A more direct contact with the individual owner was achieved through visits by CFM foresters. These foresters, who are under the supervision of the State forester, provide on-the-ground advice and technical assistance in managing woodlands. Their potential for influencing owners' decisions appears considerable. When owners

were asked what governmental services they regarded as most important, the provision of technical advice was mentioned more often than all other services combined.

CFM foresters exerted their influence by interesting owners in forestry, supplying information needed to undertake practices, and in some cases persuading owners to carry out practices. They had a minor role in interesting owners in planting but a major one in interesting them in thinning. Thirty-five percent of the owners who thinned said that they first became interested through contact with a forester—six out of seven of these were CFM foresters.

A quarter of the owners who planted and a fifth of those who thinned did so without obtaining advice or assistance. Of those who sought information about planting, more than half went to a forester, who nearly always was a CFM forester. About three-fourths of those who sought information on how to thin went to a forester, but only half of these went to a CFM forester.

Only 17 percent of those who planted and 14 percent of those who thinned could not identify the contact who persuaded them. Of those owners who could identify their contacts, a third said they were persuaded to plant by a forester, again nearly always by a CFM forester. More than 60 percent reported the contact who persuaded them to thin was a forester; three out of five were identified as CFM foresters.

Foresters in general appeared to exert more influence in persuading owners to thin than to plant. Among foresters, however, CFM men were more influential with regard to planting than to thinning. Several factors may explain this. Foresters were one group among many attempting to persuade owners to plant trees for one purpose or another. Thus their importance was less than in the case of thinning, which is a somewhat sophisticated practice seldom advocated by nonforesters. The CFM foresters tended to be associated with planting because they are major distributors of seedlings from government sources. Two-thirds of the owners who thinned had their timber marked prior to cutting. On request, various kinds of public and industrial foresters, including CFM men, provided this service.

Another form of technical assistance under the CFM program is preparation of woodland plans. Twenty-two percent of the owners had plans. Relatively more among these planted and thinned than among those without plans:

	Percent planting	Percent thinning
With plans	82	46
Without plans	67	33

The extent of the influence of woodland plans was indicated by the fact that 13 percent of the owners who planted did so because this was advised in the management plan; and 21 percent of those who thinned did so for this reason.

In the programs that enabled owners to practice forestry, the most generous provisions were those for tree planting under the ACP and the related Conservation Section of the Soil Bank program. More than 40 percent of the owners who planted received direct monetary help through one or the other of these programs. One-third received ACP cost-sharing payments at the time they planted; the other two-thirds benefited from cost-sharing payments plus the annual payments for 10 years under the Soil Bank program.[5]

DIFFERENTIAL CHARACTERISTICS OF ADOPTERS

To clarify and interpret the findings from the initial screening of independent variables, the original relationships were elaborated by introducing test factors. The test factor, in each case, was one of the other independent variables. Partial relationships were found by stratifying the sample according to the test factor and then obtaining the relationships between the original variables and the forest practices within the resulting subclasses. Marginal relationships between the independent variables and the test factors were also found.

More than 90 percent of the owners who held forests on share-tenant farms planted. Seventeen percent of all forest ownerships were on farms with this kind of operator. Half of these holdings were owned by farmers and retired farmers. Methods of acquiring share-tenant farms were similar to those used to acquire owner-operator farms, i. e., approximately 20 percent inherited their properties, 30 purchased them, and the remainder acquired theirs by combinations of methods. Ninety to 100 percent of the owners in each major occupational class planted, except that in the "other occupation" category only 75 percent planted.

Seventy percent of all share-tenant farms were in the Coastal Plain, the province where the fewest owners (50 percent) planted. No share-tenant farms were found in the Mountains, where a high proportion of owners planted.

Share-tenant farms were predominantly large. More than a third were in the largest size class (150 to 500 acres), as compared with less than 10 percent of the other classes of farms. Also, only

[5] The Conservation Reserve section of the Soil Bank program was authorized by the Agricultural Act of 1956. Although provisions of the act with regard to tree planting were eliminated in 1960, this did not halt the annual payments authorized for 10 years after planting.

about a quarter of the share-tenant farms were in the smallest size class (10 to 50 acres). In all other categories, between one-half and three-fourths of the farms were in the smallest size class.

The reasons owners of share-tenant farms gave for their decision to plant indicated that most were seeking to put their open land to best use. In describing the land they planted, for instance, some owners remarked that it "is some distance from my home," or "is more suitable for pines than for crops."

Public sponsorship of planting frequently encouraged owners. Typical answers indicating this were, "I decided to take advantage of the ACP program and put in timber," and "The Soil Bank program caused me to plant some trees."

Other owners, however, planted for more idealistic reasons. One owner of this type told the interviewer that he expects no personal benefit, but thinks "It is something people must do if we are to have any timber."

A high proportion of idle farms were planted, regardless of the owner's major occupation. Three-quarters of these farms, however, were held by business and professional men, who in the main had purchased them. This was the principal kind of farm held by members of this occupational class.

Among all persons who held idle farms, owners who were in a profession or business planted least. This seeming contradiction is explained by the size and location of their ownerships. Nearly all businessmen and professionals with forests in the medium and large size class (50 to 500 acres) planted, while only slightly more than half of those with woodlands in the small size class did likewise. Two-thirds of the owners in this occupational class, however, had forests less than 50 acres in size. Furthermore, in this occupational class all owners with holdings in the Piedmont planted, regardless of the size of their woodlands, as compared with only half of those in the Coastal Plain and a third of those in the Mountains. While half of all business and professional men's holdings were in the Piedmont, the remainder were about equally divided between the Coastal Plain and the Mountains.

Why did business and professional men who held idle farms in the Piedmont plant forest trees? The reasons expressed by several such owners help to answer this question.

A lawyer who had acquired a tract in a remote area realized that the property lacked sufficient arable land to be cultivated. He planted in hopes of "improving the value of the farm."

A real estate dealer planted a cutover area. After he had cut the timber, he decided not to clear the land for farming, but saw

that "The pines were not going to come back." He decided to plant because "The land would never be any good to me the way it was."

A veterinarian explained that he had planted for two reasons. One was "to get out of farming;" the other was "to increase the value of the land for further development as real estate." Though he took advantage of the Soil Bank program to put his entire farm in trees, it was not his intention to practice forestry. He wanted to plant the area at a very low cost and collect the annual Soil Bank payments for 10 years. Then he would retire from his practice and subdivide his farm into residential building lots. He calculated that lots covered with trees would bring higher prices than those that were bare.

Much planting was also done on owner-operated farms in the Mountains. Thirty percent of all owner-operated farms were in this province. While throughout the State the majority of farms of this kind belonged to farmers, wage earners and clerical workers held one-fourth of them, mainly in the Mountains. More wage earners and clerical workers than any other group indicated that farming was their minor occupation. Two-thirds of them operated their own farms.

The diverse reasons that wage earners and clerical workers who owned Mountain farms had for planting can be illustrated with two cases. One owner, a carpenter, planted 30 acres without financial aid from any public agency. He said that the land "would not pay me anything in any other use." He expected his family to benefit from the sale of timber.

Another owner, a sawmill worker, planted openings in his woodland. He "wanted cover on the land," and thought that "the children might benefit from the timber." But he planted only because of the availability of ACP payments.

The major groups of owners who thinned were farmers and retired farmers with share-tenant farms and farms run by "other" kinds of operators, and persons having "other occupations" who owned cash-tenant farms.

Among all occupation groups, half or more of the owners of share-tenant farms thinned. Farmers and retired farmers were the principal owners of farms of this kind. Although share-tenant farms were found largely in the Coastal Plain, location had no effect on the proportion of owners who thinned. Size of forest did have an effect—a negative one. The percentage of share-tenant farm owners who thinned declined from 95 for small ownerships, to 50 for medium ones, to 40 for large ones.

Thinning was also done on nearly all medium and large ownerships situated on farms with "other" kinds of operators when these

farms were owned by farmers or retired farmers and were located in the Coastal Plain.

Owners in the "other occupations" class held 60 percent of all cash-tenant farms, and 85 percent of these owners thinned. Three-fifths of the cash-tenant farms were in the Piedmont. In contrast to share-tenant farms, which were largest in size, cash-tenant farms were among the smallest—70 percent were in the 10- to 50-acre class.

Why did these owners practice thinning? Although answers varied, the potential income played a role in most of their decisions. One young farmer said that he had had his timber marked and thinned to "make money." He had previously worked as a pulpwood producer and thought of forestry entirely in terms of financial returns. Another farmer, an elderly man, said that his interest could be traced to the activities of foresters from a nearby pulpmill. He mentioned that he had also made several profitable timber sales.

Financial objectives for thinning were somewhat less pronounced among those having "other occupations" who owned cash-tenant farms. An elderly widow, for example, thinned because a State forester had advised her to. He marked the trees; her son-in-law cut them and paid her for the stumpage. An unemployed disabled veteran of World War II thinned as part of an intensive program of forest management he was attempting to carry out in his small forest. He was proud of the appearance of his woodland as compared to that of his neighbors. He explained his reasons for thinning in this way: "I don't have very much timber so I want to keep what I do have in the best condition possible. I cannot get insurance on myself so I feel that my timber offers some insurance."

SUMMARY AND CONCLUSIONS

This investigation appraised the external factors and personal characteristics—and by inference indicated the motivations—of landowners who had adopted two divergent kinds of forestry practice. Of the wide range of factors examined, it yielded evidence that a number of them are related either to planting or thinning. Most of the independent variables associated with one or the other of these two practices could be grouped on the basis that they indicated: major occupation of owner, size of forest ownership, geographical location of ownership, or kind of farm operator where the forest ownership was situated. It found further that in several major categories, involving combinations of factors, a high proportion of the owners had planted or thinned. Finally, it reported the principal reasons that individuals in each group expressed for having planted or thinned.

Beyond simply adding to our knowledge of this class of forest landowners and providing additional insight into their behavior, these findings should be of primary value for guiding promotional activities by forestry agencies responsible for encouraging landowners to practice forestry. They may wish to concentrate their efforts on those categories of owners most responsive to undertaking certain kinds of practices. Owners of share-tenant farms, for example, appeared most receptive to both planting and thinning. Other owners thinning in high degree were those with cash-tenant farms and farms with "other" kinds of operators. While owners of woodlands in the Mountains were unwilling to thin, they were willing to plant. Owners who planted in the greatest proportion, however, were those with idle farms. Most idle farms were located in the Piedmont and owned predominantly by business and professional men. Agencies should be aware of the fact that while owners adopt forestry mainly for monetary returns, not all expect to realize these returns from the sale of timber.

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WOOD MACHINING ABSTRACTS, 1966 AND 1967

Peter Koch

The purpose of this paper is to abstract significant wood-machining research that has not been previously digested in English-language texts and bibliographies.[1] The bulk of the references considered are from 1966 and 1967, but an attempt was made to include important papers that had been missed in the earlier searches. Principal sources of information were the major world journals in wood science and technology, FORESTRY ABSTRACTS, and personal communications with researchers known to be active. Only papers of research nature are abstracted. The reviewer recognizes that limits of time and linguistic ability have probably caused omissions and misinterpretations.

Each paper is abstracted under its major subject-matter category; the large categories are subdivided. To enhance utility, papers are cross-referenced in all pertinent categories. Cross-references take the form:

Doe. 1966. (Sawing; Bandsawing)

Such a reference indicates that the full citation, with abstract, appears in the Sawing category, under the subhead Bandsawing. The subject-matter heads are summarized in the table of contents. In one category, Boring, Routing, and Carving, no published papers were located during 1966 and 1967. An index of authors appears on page 37.

HIGHLIGHTS OF THE LITERATURE

The abstracts indicate that total research effort is increasing. The preceding review contained 180 references from the years 1963 through 1965—an average of 60 per year. The present paper contains 138 titles from 1966 and 103 from 1967.

The total number of references in the present review is 326. Sawing research leads in activity, with 75 papers listed. Of these, 24 were concerned with gangsawing and 14 with circular sawing.

Information on chipping was presented in 56 papers. Of these, 23 reported field trials of chipping headrigs and edgers. Industry has moved rapidly in the last 5 years to apply this laboratory-developed concept (Koch 1967, Chipping, Chipping Headrigs and Edgers).

Properties of the cutting edge and cutter have received great attention, with 53 papers published. Saw blade stability was the subject of 13 of these. Twelve dealt with dulling phenomena, and 17 with fitting and sharpening.

Nineteen papers were devoted to veneer cutting, 17 to barking, and 10 to coated abrasives. Research instrumentation was discussed in ten papers, and the machining of particleboard was the subject of several. It is of interest that seven publications were devoted to the problem of noise created by woodworking tools. Seven explored the history of wood machining.

North American workers were active in studies of orthogonal and veneer cutting, and in research that led to the development of the chipping headrig. German, Swedish, French, Russian, Australian, and Japanese laboratories studied sawing (particularly with the sash gangsaw), machining with coated abrasives, chipping, properties of cutting edge and cutter, and the machining of particleboard. Lucid English translations (with standardized nomenclature) of the major publications of these lab-

[1] The chief previous compilations are:

Committee on Recent Wood Machining Literature. Wood machining abstracts, 1957-1958. Forest Prod. Res. Soc., Madison, Wis. 20 pp. 1959.

Committee on Recent Wood Machining Literature. Wood machining abstracts, 1958-1959. Forest Prod. Res. Soc., Madison, Wis. 19 pp. [1960.]

Committee on Recent Wood Machining Literature. Wood machining abstracts, 1959-1961. Forest Prod. Res. Soc., Madison, Wis. 18 pp. 1961.

Koch, Peter. Wood Machining Processes. 530 pp. New York: Ronald Press Co. 1964.

Koch, Peter, and McMillin, C. W. Wood machining review, 1963 through 1965. Forest Prod. J. Part I, 16(9): 76-82, 107-115; Part II, 16(10): 43-48. 1966.

oratories would contribute much to the wood machining technology of the English-speaking countries. Some assistance in this direction will be provided by a new journal, WOOD SCIENCE AND TECHNOLOGY, established in 1967 by the International Academy of Wood Science. Though printed in West Germany it will be primarily in the English language.

Despite the obvious risk of offending researchers by omission or misinterpretation, it seems worthwhile to attempt some mention of individual papers in various categories of endeavor.

History.—Brief histories of progress in wood machining were provided by Thunell (1967) and Koch (1967).

Properties of wood.—McKenzie (1966) and Wardrop (1966) discussed the anatomy of wood as it relates to certain machining processes. DeBaise *et al.* (1966) and Necesany (1965) considered cell-wall structure and factors that affect strength values as they pertain to machining.

Orthogonal cutting.—Fengel (1967) explained procedures in cutting ultrathin sections of wood for examination under the electron microscope. Endersby (1965) and Lutz *et al.* (1967) continued to explore how tool velocity affects the cutting process. Stewart (1967) investigated the effect of grain angle on the quality of surface produced by orthogonal cutting. McKenzie and Hawkins (1966) studied the quality of near-longitudinal wood surfaces formed by inclined cutting. Thunell and Aoyama (1966, Peripheral Milling) made microscopic observations of surfaces generated by sawing, planing, and sanding. Collins (1965, Patents) patented a method and apparatus for longitudinally slicing thick pieces of wood with a vibrating heated knife.

Peripheral milling.— Mori (1966) continued his studies of the planing process.

Barking.—Nakamura and Ohira (1963) and Vogt (1965) developed information on the adhesion of bark to wood. Plotnikov and Polozov (1966) described tests with a pneumatic barker that utilizes a mixture of compressed air and sawdust as the debarking agent.

Sawing.—Hallock (1966) and Koch (1966) devised two new processes for converting southern pine timber into straight, dry 2 by 4's. Hallock's method is best applied to larger logs, while Koch's is applicable only to logs less than 7 inches in diameter.

Sash gangsaws received considerable attention. Porter (1966) observed that wavy-edged lumber results from log displacement and loss of saw tension. Thunell (1966) found that sawing accuracy diminished slowly but constantly with increasing feed rate, and Thunell and Wallin (1966, 1967) stated that feed per stroke has a great influence on sawing force at all positions of the crankshaft, that peak forces increase as wood temperature declines below freezing (particularly in the range below —15 degrees C.), and that cutting forces rise as much as 100 percent in knots and 50 percent in compression wood.

Demsky (1967) and DuClos (1967) described the advantages of side cutters on the circular saws of a double-arbor edger. These cutters, in combination with carbide saw teeth having 40° rake angle, permit thin-kerf sawing.

Jones (1966) gave specifications of circular trim saws for plywood. Malcolm (1967) sawed red oak with bites per tooth of ⅛ to ¼ inch and studied the effect on circular saw performance. He also evaluated the strength of pulps made from the resulting sawdust.

Fujii *et al.* (1967), Gambrell and Byars (1966), and Pahlitzsch and Peters (1966) observed the cutting characteristics of chain saw teeth.

Kempe (1964) studied cutting forces and damage to fiber structure in round wood crosscut with a hydraulic shear.

Jointing, planing, shaping.—Rietz and Jensen (1966) found that surface checking of oak was minimized by presurfacing prior to kiln drying. Prokes (1965) determined effects of wood and cutter factors on quality of surfaces formed by peripheral milling across the grain. Strickler (1967) described impression fingerjointing, a new method of end-gluing lumber; it employs a heated die (approximately 500° F.) to form the joint ends.

Boring, routing, and carving.—Pahlitzsch and Jostmeier (1966, Properties of the Cutting Edge and Cutter; Dulling) studied the dulling of router cutters in particleboards of various compositions.

Machining with coated abrasives.—Nakamura (1966), Pahlitzsch and Dziobek (1962),

and Seto and Nozaki (1966) performed basic research on machining with coated abrasives. Sternal (1967) recommended abrasive planing for glued-up lumber, banded material, and panels that require a cut less than 3/64-inch deep. He stated that abrasive planing is not practical on green lumber and has very limited application on rough, dry lumber.

Veneer cutting.—Nearn (1965) and Ainslie (1965) observed that earlywood ruptured across the cells when Douglas-fir was rotary-peeled, whereas latewood tended to separate between cells. Lutz (1967) recommended that southern pine veneer bolts be peeled at temperatures from 140 to 160° F. Effects of bacterial action during storage of southern pine veneer bolts in warm water were studied by Lutz *et al.* (1966). Lutz and Patzer (1966) disclosed the effects of horizontal roller-bar openings on the quality of rotary-cut southern pine and yellow-poplar veneer. Feihl and Godin (1967) described the benefits of a microbevel on the cutting edge of a veneer knife and recorded procedures for setting veneer lathes. Lutz (1967) surveyed the history, current industrial usage, and research status of the roller pressure bar, the inclined cutting principle, and veneer cut thicker than ¼ inch.

Chipping.—According to Larsen (1966), properties of sulfite pulp were enhanced when chips were made with the Soderhamn drum and H-P spiral chippers. Nolan (1967), Scott (1966), and Vethe (1967) discussed the process of chip shredding. Schmied (1964) explained why it is desirable to cut pulp chips to a uniform size and to the proper shape. Wahlman (1967) stated that the optimum chip thickness for alkaline pulping is 2 to 5 mm. Pahlitzsch and his associates (1963, 1966, 1966, 1966) described fundamental aspects of cutting chips and flakes with disk and drum chippers.

Koch (1967) traced the development of three configurations of chipping headrigs and described the capability of the shaping-lathe configuration. Dobie *et al.* (1967) studied the production capabilities of six chipping headrigs, six scrag mills, and from four log gang mills. He concluded that chipping headrigs recover 50 to 60 percent of the cubic input as lumber, make 5 percent sawdust, have an effective lineal feed speed of 59 f.p.m., and permit recovery of more chips than do other headrigs.

Logan (1966) recorded Domtar's efforts to develop a mobile, year-round, tree-length harvesting system that would be cheap and could be operated around the clock.

Defibrating.—Gavelin's 14-chapter book on mechanical pulp manufacture (1966) has an introduction by Atack stating that disk-refining of wood chips and residuals is the most revolutionary innovation in mechanical pulping since the introduction of the commercial stone grinder in 1856. Loblolly pine fibers pulped with peracetic acid and then refined in a PFI mill were shown by McIntosh (1967) to have delaminated into many concentric lamellae.

Properties of the cutting edge and cutter.—Pahlitzsch and Rowinski (1966, 1967), in a series of four papers, explored the vibration of circular saw blades. Jones *et al.* recommended a particular saw tooth profile to promote tooth stiffness and stability. McKenzie (1967) stated that moisture content, tool roughness, and cutting speed affect coefficient of friction between tool and chip.

Nomenclature.—The advantages of establishing a uniform terminology were discussed by McKenzie and Bolza (1965), Thunell (1966), and Wuster (1966).

Machinability of lumber and particleboard.—The milling of particleboard was investigated by Iliev *et al.* (1967), Olszewski (1967), Pahnutova (1966), and Pahlitzsch and Jostmeier (1966).

Safety, including noise.—An unsigned British publication (1967) describes how the noise levels frequently found in woodworking plants may damage hearing.

ALL THE WOOD, BUT NOT THE BARK?

Utilization of the entire tree is one of the primary goals of wood scientists everywhere. It is becoming apparent that this goal is not far from accomplishment. As Kempe (1964, Sawing; Shearing) and others have observed, kerfless shears for felling trees and bucking logs will be used increasingly in industry. Chipping headrigs (Koch 1967) are reducing logs and bolts to cants without creating sawdust. Lutz and Peters at the USDA Forest Products Laboratory are nearing success in their long-term efforts to achieve kerfless slicing of

cants into thin lumber, and industry is anxious to accept the idea (Collins 1965, Patents). Increasingly, tree tops to 3 inches in diameter are being chipped at both portable and fixed installations. As observed by Koivelehto (1966, Chipping, Flaking, and Grinding; Chipping), machines are being developed to chip stumpwood for pulp. The southern pine naval stores industry has greatly improved machines for removing stumps from the ground.

Mechanical conversion research by McMillin of the USDA Forest Service laboratory at Alexandria, Louisiana, and by others, is aimed at increasing the tonnage recovery in the fiber industry. A good understanding of how high-yield, disk-refined fiber can be manufactured for specific applications will permit a broad range of strong products to be made from such fiber. Another result will be the virtual elimination of pulping loss in the manufacture of many products, with consequent stretching of the timber resource. Thus the fiber industry, as well as the solid wood products industry, is moving toward complete utilization of all the wood in every tree.

In the author's opinion, this discussion points to two clearly defined but as yet unsolved problems.

First, a successful method of separating bark from chips would permit the chipping of small-diameter tops and branchwood with bark in place. While there are at least two patented processes for removing bark from wood chipped with bark in place (Hosmer and Vac-Sink), industry has never applied them on a large scale. Seemingly the processes need a better trial or new processes need to be invented.

Second, while use of virtually all of the wood in the tree is technically almost within reach, bark is not nearly so well utilized. Most mills burn it as a low-value fuel; in these days even this use is suspect because of resultant air pollution. Some mills are converting limited tonnages of bark into various agricultural mulches. A few are making chemical and fiber products from bark. It appears to the author that the invention of additional processes to convert bark into profitable products should be given high priority by researchers everywhere.

HISTORY AND GENERAL TEXTS

Anonymous. 1967. ANNUAL MACHINING REVIEW. Ind. Woodworking 19(11): 14-29.
Illustrates and briefly describes 35 new models of woodworking machines.

Anonymous. 1967. THE MELLONS OF PITTSBURGH. Fortune 76(5): 121-129, 238-254.
In 1904 Edward G. Acheson, a Pennsylvanian, approached A. W. and R. B. Mellon for financial assistance in manufacturing his newly invented electric furnace process for fusing sand, coke, and salt into silicon carbide. In return for a 1/16 interest in what was to become the Carborundum Company, the Mellons took up $50,000 worth of a $75,000 bond issue that Acheson floated. The money was used to move the company to Niagara Falls. The cheap electric power available there was a key element in the economic feasibility of the process.

Afanas'ev, P. S. 1966. WOODWORKING MACHINES. A MANUAL. 635 pp. Izdatel'stvo 'Masinostroenie,' Moscow.
A compilation of information on Soviet saws and other woodworking machines, giving the specifications of all models; details of the cutting tools and of machine assembly, modernization and use; and data for calculating machine design and output.

Koch. 1967. (Chipping, Flaking, and Grinding; Chipping Headrigs and Edgers)

Koch, P. 1967. HISTORY OF WOOD MACHINING. Wood Sci. and Technol. 1(3): 180-183.
Briefly traces development of wood machining as related to advances in metallurgy and power sources. Shows relationship between the history of wood machining and the rise and fall of other industries. Emphasis is on developments in North America.

Korda, J. 1966. THE 150TH ANNIVERSARY OF THE BIRTH OF THE MAN WHO INVENTED GROUNDWOOD. Papir a Celulosa 21(6): 189-190.
On the 150th birthday of Friedrich Gottlob Keller, the inventor of groundwood, the author presents a short biography, and outlines the history of the discovery. Keller's long and unsuccessful attempts at introducing wood as a papermaking raw material, his association with the owner of a papermill, Heinrich Voelter, and his final recognition first in the form of royalties for his patent from the U.S.A. in 1870, and then, a few years before his death in 1895, in the form of honors and a pension. In 1898, when a commemorative plaque was unveiled on Keller's house, the worldwide production of groundwood reached 3 million tons.

Prokes, S. 1966. HISTORY OF WOODWORKING TOOLS. Drevo 21(9): 318-320.
Outlines the prehistory and records detailed calendar of developments from 1500 A. D. through 1926.

Richards, J. 1966. SELECTIONS FROM A TREATISE ON THE CONSTRUCTION AND OPERATION OF WOODWORKING MACHINES. Forest Hist. 9(4): 16-23.

mons, E. N. 1966. THE EVOLUTION OF THE SAW. PARTS I ND II. Wood 31(9): 33-36; 31(11): 37-40.
races development from the flint saws of Swiss Lake wellers (4500 B. C.), to the bronze saws of Egypt and rete (circa 1500 B. C.), to the iron saws of early Roman mes, and finally to the steel saws of Europe in the 15th rough the 17th centuries A. D. Invention of the saw set, well as the frame saw, is attributed to the Romans. The rliest known water mills were used at Augsburg, Ger- any, in 1332-1337, but a 13th century frame-saw manu- cturer illustrates a water-wheel saw. The first circular w is believed to have been used in Holland toward the d of the 17th century. The rolling of steel saw plates for rcular saws was invented by Thomas Boulsover of Shef- eld, England, in the mid-18th century.

hunell, B. 1967. HISTORY OF WOOD SAWMILLING. Wood ci. and Technol. 1(3): 174-176.
he industrial revolution in the sawmill industry occurred the second half of the 19th century. From that time, roductivity of sawmills has steadily increased. Today, northern sawmills are 2½ to 3 times more productive than they were 20 years ago. The objective of recent research has been to increase the stability of circular saws, to improve the feed system for gangsaws, and to increase production and decrease kerf of all types of saws. Saws that cut pulpable sawdust and chipping headrigs that made no sawdust are recent innovations. Current research is concerned with creating mathematical models for the sawmill process as a step toward computer analysis and control. Kerfless sawing, through application of slicing knives, water jets, or lasers, is also under study. Active research on sawing is in process in the USSR, Germany, the Eastern European nations, Japan, Norway, Sweden, Finland, and the USA.

Wilkins, G. R. 1966. HISTORY OF CIRCULAR SAWS. Timber Trades J. Annu. Spec. Issue: S/1-S/3, S/27, S/29.
Traces the development of circular saws, believed to have been invented in Holland between 1600 and 1700. Describes various 19th-century designs from Britain, France, and America.

PROPERTIES OF WOOD

eBaise, G., Porter, A., and Pentoney, R. 1966. MOR- HOLOGY AND MECHANICS OF WOOD FRACTURE. Mater. Res. nd Stand. 6(10): 493-499.
a study of western white pine it was observed that ood fracture began with stable extension of intrinsic aws at low-stress values. Growth of flaws was dependent pon the kind and direction of the loading stress. Flaws ctended with time for creep and relaxation conditions in characteristic manner for each type of test. Crack propa- ation in the radial- and tangential-longitudinal planes for e opening-cleavage mode of fracture had similar strain nergy release rates, which were functions of temperature nd moisture content. In the radial-longitudinal plane, ow fracture formed a smooth surface and occurred pre- ominantly between the middle lamella and the primary ell wall and between the latter and the S_1 cell wall. urface of failure for rapid fracture was through all the ell-wall layers, which exposed the cell lumens. Transition om slow to rapid fracture usually occurred at a ray cross- g or at tracheid ends.

rey-Wyssling, A., and Stussi, F. 1948. CELL DEFORMA- ION UNDER COMPRESSION. J. Forest. Suisse 99(3): 106-114.

IcIntosh. 1967. (Defibrating)

IcKenzie, W. M. 1966. WOOD AS A RAW MATERIAL TO BE UT—THE BASIC REQUIREMENTS OF CUTTING DEVICES. Holz ls Roh- und Werkstoff 24(9): 380-389.
utting is defined as the application of energy to divide workpiece at some chosen interval, and in a way that eeps extraneous ruptures within acceptable limits. As material to be cut, wood can be regarded as consisting f three phases: (1) crystalline S_2 cells, (2) amorphous gnified middle lamella, primary wall and S_1 layer, and 3) lumen filled with air or water. Requirements for utting devices are developed in the light of this structure. he nature of wood places very exacting requirements on uccessful cutting devices. The conventional rigid-wedge cutters have some firm advantages with possibilities for further improvement. The water jet is the only new device with immediate promise.

Necesany, V. 1965. EFFECT OF HEAT AND MOISTURE ON THE PROPERTIES OF THE MIDDLE LAMELLA. Drev. Vyskum 3: 149-154.
Twenty-millimeter beech cubes were steamed for 4 hours at 4 kg. per square centimeter and 140° C., and then split radially and tangentially at wood temperatures of 100, 80, 60, and 20° C. Damage to the cell walls was photographed with an electron microscope. The plasticity of the wood caused by steaming is due mainly to the plasticity of the middle lamella. This plasticity still remains even at temperatures less than 100°, but decreases with decrease in wood temperature; when the wood has cooled completely, the original strong bond between the cell walls is more or less completely restored. Accordingly, the ideal wood temperatures for peeling and slicing veneers are below but close to 100°.

Wardrop, A. B. 1966. Morphological factors involved in the pulping and beating of wood fibers. Svensk Papperstidn. 66(7): 231-247.
Reviews the structure of the cell wall with special reference to distribution of constituents and physical organization. In chemical pulps, fiber separation occurs in the true middle lamella; in some semichemical processes, such as the cold soda, the initial separation occurs between the outer and middle layers of the secondary cell wall. Beating chemical pulps involves the removal of the primary wall followed by removal of successive lamellae from the outer layer of the secondary wall. Beating semichemical pulps separates as a single unit the region external to the middle layer of the secondary wall. The exposed surfaces produced by chemical and semichemical pulps differ morphologically. The influence of chip damage is greatest in acid pulping media and results in fiber breakage during pulping and beating.

Collins. 1965. (Patents)

Endersby, H. J. 1965. THE CUTTING ACTION OF WOODWORKING TOOLS. *In* IUFRO Proc. 1965, Vol. 3, Sect. 41, 7 pp. Melbourne.
In the cutting-speed range from 1,000 to 9,000 f.p.m. changes in speed have little effect on the value of cutting forces. However, as the tool speed is reduced from 1,000 to 7 f.p.m. the horizontal force increases about 2½ times. This correlation between force and velocity must be recognized by researchers, since tool speeds in industry usually exceed 1,000 f.p.m.

Fengel, D. 1967. ULTRAMICROTOMY, ITS APPLICATION IN WOOD RESEARCH. Wood Sci. and Technol. 1(3): 191-204.
Preparation of ultrathin sections of wood for examination under the electron microscope requires a suitable imbedding medium (methacrylate), precise feed (by means of thermal expansion of a metal feed rod), a sharp and durable cutting edge (diamond), and an effective means of removing the fragile serial sections (on top of a water surface). The development of each of these aspects is outlined. The compact structure of the woody cell permits no penetration of the imbedding medium; thus a phase boundary exists between cell wall and medium. The imbedding medium must adhere to the cell walls. Thin-walled cells with large lumens accept the medium better and yield better sections than do thick-walled cells with small lumens. Further, at the moment of cutting, polysaccharide molecules with active hydroxyl groups are exposed and immediately form bonds with water or with each other under influence of compression from the knife edge. In wood research methacrylate is the preferred imbedding medium. A detailed procedure for specimen preparation is presented. With glass knives the author was able to cut sections as thin as 800 Å. but could get only three or four good sections per knife. With diamond knives, he could cut serial sections as thin as 500 Å. The paper includes 66 references.

Lin, C. C. 1965. SURFACE FINISH IN WOOD CUTTING. M. S. Thesis. Univ. Calif. Berkeley.
Experiments with orthogonal cutting of Douglas-fir and redwood confirmed the formation of three distinct types of chip, as described by Franz, and showed that conditions producing Type II chip formation give the best surface finish. Analysis of surface profiles showed that cell size is important in determining surface roughness. Surface roughness was found to increase with increasing speed of cutting. The effect of cutting speed was most pronounced on deep cuts.

Lutz, J. F., Mergen, A., and Panzer, H. 1967. EFFECT OF MOISTURE CONTENT AND SPEED OF CUT ON QUALITY OF ROTARY-CUT VENEER. U. S. Dep. Agr. Forest Serv. Res. Note FPL-0176, 14 pp. Forest Prod. Lab., Madison, Wis.
High moisture content in the wood and high cutting speed resulted in higher loads on the roller bar than when moisture content was moderate and cutting speed was slow. Southern pine peeled to a nominal thickness of 0.094 inch at 110 percent moisture content exerted a rollar-bar load of 382 pounds per inch of bar when cutting speed was 300 f.p.m., and 333 pounds when speed was 20 f.p.m. At 60 percent moisture content comparable figures were 326 and 255 pounds per inch of bar. Yellow-poplar heartwood (at approximately 105 percent moisture content) similarly peeled, exerted 261 pounds per lineal inch of bar at 300 f.p.m., 240 pounds at 20 feet, and 190 pounds at 0.2 foot. In genral, veneer cut with high loads on the roller bar was thinner and weaker in tension perpendicular to the grain than veneer cut with moderate loads on the roller bar.

McKenzie. 1966. (Properties of Wood)

McKenzie, W. M., and Hawkins, B. T. 1966. QUALITY OF NEAR LONGITUDINAL WOOD SURFACES FORMED BY INCLINED CUTTING. Forest Prod. J. 16(7): 35-38.
Orthogonal cuts were made with a stationary disk (11½ inches in diameter) on radiata pine (Pinus radiata) *and mountain ash* (Eucalyptus regnans). *Inclined cuts were made on the same species with a rotating disk. Clearance angle was 3° and cutting-edge radius was 6 microns. On trials with cutting edge perpendicular to the grain and cutting longitudinally in the planing direction, with rake angles of 10, 30, 50, and 70° to form chips 0.002, 0.005, 0.010, and 0.030 inch thick, it was observed that inclination (rim speed/feed speed = 94) should permit a smaller rake angle, i. e., a stronger cutter or a blunter edge to be used successfully on air-dry wood when cutting with the grain. Inclination should also enable acceptable surfaces to be obtained when feeding against the grain if the chip thickness is less than 0.01 inch. On trials with cutting edge angles (sharpness angles) of 30, 50, and 70° to form chips 0.002, 0.020, 0.040, and 0.080 inch thick, it was observed that inclination (rim speed/feed speed ratio of 94 and also 375) enabled thicker chips to be taken or lower rake angles and blunter edges to be used on air-dry wood. Surface roughness was reduced with inclined cutting of veneer from green wood, but results were inconclusive as to the quality of the veneer formed.*

Okohira, Y. 1963. A DISCUSSION ON THE CLEAVAGE OF WOODEN ROD. Mie Univ. Fac. Agr. Bull. 28, pp. 177-197.
Applies the Fourier series in a mathematical study of the stresses occurring in small pieces of wood split with symmetrical forces. Gives equations for the stress concentrations in different planes.

Stewart, H. A. 1967. AN ANALYSIS OF ORTHOGONAL WOOD-CUTTING AGAINST THE GRAIN. Master Wood Sci. and Technol. Thesis. Univ. Mich. Ann Arbor.
White ash (Fraxinus americana) *was conditioned to 7.2 percent moisture content and cut orthogonally at 4.5 inches per minute against varying grain inclinations from 0° (90 to 0° direction) through 30° (90 to 30° direction). Chipped grain occurred when grain angles were less than 15° but were avoided when knife rake angle was 20° or less. For specific grain angles, there was an optimum combination of depth of cut and rake angle. Very shallow cuts in wood with a large grain-angle produced poorer surfaces than deeper cuts. The Franz analysis was employed to relate mechanical properties of the wood to chip type and surface quality produced at varying grain angles. Parallel and perpendicular cutting forces are tabulated.*

Sugihara, H., Noguchi, M., Okushima, S., and Nomura, K. 1966. WOOD CUTTING WITH A PENDULUM DYNAMOMETER. PART VI—RELATION AMONG CUTTING ENERGY, CUTTING FORCE AND TYPE OF CHIP FORMATION. Wood Res. 39, pp. 1-12.
The relation between energy consumption E and the mean main component of the cutting force P_0 was determined to be $E = E_0 + \Delta E$, $E_0 = P_0 \cdot S$, and $E = \gamma \cdot S$, where S is the cutting length and γ is a constant. Radial components of the cutting force tended to be negative with cross-sectional cutting (bark to pith), radial sectional cutting parallel to the fiber, and radial sectional cutting perpendicular to the fiber. The radial component decreased and was apt to

ecome negative with increased depth of cut and rake ngle. This component was larger in air-dried specimens han in water saturated ones. Critical rake angle decreased vith increased depth of cut. It was constant at 40° with .10 mm. depth of cut and 15° clearance angle, regardless f cutting direction and wood species. Tear-type chips were btained with cross-sectional cutting, flow and broken chips vith radial sectional cutting perpendicular to the fiber. ncreased depth of cut yielded broken chips when cutting vas perpendicular and parallel to the fiber. Weight of the pendulum had no decisive influence on the measured energy consumption.

Walker, K. J. S., and Goodchild, R. 1960. THEORY OF CUTTING. PART I—EXPERIMENTS IN RECTILINEAR CUTTING. Forest Prod. Res. Spec. Rep. 14, 26 pp. London.
Reports the effect of chip thickness, cutting angle (rake angle), and cutting speed on cutting forces and chip formation when cuts parallel to the grain are made with a modified sledge-type microtome and high-speed (whirling arm) apparatus.

PERIPHERAL MILLING PARALLEL TO GRAIN

Anonymous. 1966. NEW CUTTER BLOCK. Timber Trades J. 57(4680): 67.
Describes a cutter block, the Adjustable Milling Head esigned by Orton Saws, Ltd., of Beeston Notts, which nables cutters to meet the workpiece at a wide range of ngles. The cutter block holds four knives instead of two. dvantages claimed are virtual elimination of cutter breakge, extended cutter life, and a better and more even finish n the workpiece.

Koshi, T. 1967. PROPERTIES OF IMPORTANT JAPANESE WOODS. CUTTING PROPERTIES BY ROTATING KNIFE. (II)—CUTTING PROPERTIES OF WOOD. Government Forest Exp. Sta. Bull. 200, pp. 185-194. Tokyo.

Korcago, I. G. 1965. GEOMETRY OF THE NOMINAL CHIP IN ROTARY CUTTING. Les. Zh. 8(6): 120-125.
Although the kinematics of rotary cutting are always the ame, it is expedient for determination of the linear dimensions of the chip to distinguish cutting with small, medium, and large feeds per cutter, as with each of these regimes the chip has its own particular shape characteristics.

Mori, M. 1966. FUNDAMENTAL STUDY ON THE PERIPHERAL MILLING PROCESS OF PLANING LUMBER. Kyushu Univ. Forest. Bull. 39, pp. 1-108.
In three parts. Part I deals with the mechanics of chip formation during planing with rotary cutters, and includes a mathematical study of the process, with equations; e. g., it relates the path taken by the knife tips to the thickness of cut and the constantly changing direction of grain. This part also includes a study of the cutting process by means of high-speed cinematography. Part II considers the working properties of wood and analyzes the factors affecting the cutting forces and type of surface formed. Part III is an account of studies on the effect of the jointing operation on the cutting efficiency of a head with multiple knives.

Sugihara, Noguchi, Okushima, and Nomura. 1966. (Orthogonal Cutting)

Tihonov, V. A. 1966. INVESTIGATION OF THE ACTION OF A CHIP-BREAKER IN RECTILINEAR CUTTING OF WOOD. Les. Zh. 9(5): 89-93.
Reports tests on a planer apparatus previously described. Optimum sharpness angle of the chip breaker is 50° when the cutter has a clearance angle of 10° and a sharpness angle of 45°. For these conditions, and chip thicknesses of 0.3 to 0.5 mm., the knife edge should be 0.5 mm. from the edge of the chip breaker.

Walker and Goodchild. 1960. (Orthogonal Cutting)

BARKING

Anonymous. 1965. SYMPOSIUM ON MECHANICAL BARKING IN FINLAND. Finn. Pap. and Timber 16(10): 166-168.
Briefly discusses the program of the symposium organized by the FAO/ECE/ILO Joint Committee on Forest Work Technique. Prints photographs of some of the barkers used in Finnish forests and mills.

Anonymous. 1966. LARGE SWEDISH PULP MILL BOASTS HIGH-CAPACITY AUTOMATED WOODHANDLING. Pulp and Pap. 40(49): 44-46.
Briefly describes Billeruds' pulpmill at Gruvön. Timber arrives unbarked, unsorted, and in standard lengths of 3 m. A special steam bath—used only in cold seasons—was built into the transport lines carrying spruce and pine logs to their separate barking drums. Birch is steamed and then barked in bundles in a special pocket barking machine. After a few minutes in the steam bath, the logs proceed on rollers and are thrown into barking drums at a speed of 5 m. per second. The barking drums are larger than conventional drums, having a length of 34 m. and a discharge end diameter of 3.35 m. The speed is higher than usual, 9.6 r.p.m. Barking capacity for spruce is 90 cubic m. per hour; for pine, 110 cubic m.

Anonymous. 1966. MORBARK SYSTEM POLE PEELERS. Wood Preserv. News 44(9): 12.
The Morbark Pole Peeler system, manufactured by Morbark Debarker Company of Winn, Michigan, has complete circumference control enabling maximum pole circumferences to be obtained. It also has a single unit roughing and planing head that produces finished poles. The manufacturer states that one operator can produce an average of 400 utility poles per 8-hour shift.

Anonymous. 1966. SYMPOSIUM ON MECHANICAL BARKING OF TIMBER. FAO and ECE Joint Comm. on Forest Working Tech. and Training of Forest Workers. 612 pp. Europe. U. N. Office Geneva.
Includes 36 papers read at the symposium.

Anonymous. 1967. DE-BARKER DEVELOPMENT. Timber Trades J. 261(4735): 58.

Berlyn, R. W. 1966. BARK REMOVAL STUDIES AT THE INSTITUTE (PULP AND PAPER RESEARCH INSTITUTE OF CANADA). Trend 7: 10-13.
bark-to-wood bonding strength are described in detail. Procedure and equipment for laboratory determination of Laboratory tests on poplar and spruce trees in early summer

and fall showed pronounced variation in bonding strength with changes in season and species, but variation associated with tree diameter, elevation of the sample on the tree, and aspect were of no practical importance. Bark-to-wood bond was stronger in fall than in early summer; species differences were significant only in fall. In a later study, sticks of hardwood (10 species) and softwood (5 species) were barked in an Ingersoll-Rand "Hydravat" barker with a drum 12 feet in diameter and 45 feet long. Performance was affected by bark-to-wood bonding strength, bark thickness, and time in drum. A similar study was made with tree-length softwood stock in a 30-inch Beloit Hi-Speed Ring Debarker. Although analysis of data was not complete, bark-to-wood bonding strength and bark thickness affected performance. Freezing increased bark-to-wood bonding strength 2½ to 5 times. Barking behavior of samples in the commercial machines is described in detail.

Bocanet, G. 1965. MATHEMATICAL SUBSTANTIATION OF THE EFFECTIVENESS OF ROTARY BARK REMOVAL EQUIPMENT OF BEECH WOOD. Ind. Lemnului 16(6): 213-216.

Kawashima, H. 1965. A STUDY OF LOG BARKING WITH TWO TYPES OF BARKERS. Hokkaido Forest Prod. Res. Inst. J. 14(160): 6-10.

Kolm, J. 1966. PROTOTYPE OF A NEW BARKING AND TRIMMING MACHINE. Holz-Kurier 21(40): 4.

Lauryn, M., and Macak, Z. 1965. SOME ECONOMIC PRINCIPLES OF THE MECHANIZED REMOVAL OF BARK. Lesnicka Prace 44(12): 506-512.

Nakamura, G., and Ohira, Y. 1963. SEASONAL VARIATION IN BARK PEELING CHARACTERISTICS OF SOME SPECIES IN JAPAN. Government Forest Exp. Sta. Bull. 155, pp. 111-126. Tokyo.
Bark peeling resistance of 38 species (8 conifers and 30 hardwoods) decreased relatively fast in late April and early May, reached a minimum in May and June, then gradually increased to a maximum in December and January. Variations corresponded to changes in the cambium, with a marked time lag appearing between softening and division in the cambium.

Ohira, Y., and Nakamura, G. 1965. ON VOLUMETRIC WEIGHT, BARK RATIO, WEIGHT LOSS, AND BARK ADHESION DURING STORAGE OF SMALL-DIAMETER LOGS. Government Forest Exp. Sta. Bull. 176, pp. 135-150. Tokyo.

Plotnikov, V. I., and Polozov, M. I. 1966. PNEUMATIC BARKING OF WOOD. Lesnaya Promsyl. 46(12): 10-11.
An experimental pneumatic barker was developed as a result of theoretical and laboratory studies carried out since 1963 at the Technological Academy of Leningrad. The barker separates and grinds bark by the impact of a mixture of compressed air and wood particles (sawdust with average diameter of 2 mm.), the wood particles being accelerated to ultrasonic velocity. The essential parts of the barker are specially constructed nozzles, so placed on the periphery of two ring-shaped frames, that the air jets cover the whole surface of the advancing log. The bark particles fall onto a slanted screen; particles retained by the screen are eliminated, those passing through the screen are collected for reuse. The barker was extensively tested on softwood and hardwood logs, and construction data are available. The machine is suitable for irregularly shaped logs and those with many knots. The optimum composition of the barking mixture is 99.5 to 99.7 percent air with 0.5 to 0.3 percent by volume of wood particles, and the optimum pressure at the outlet of the nozzles is 8 to 10 atmospheres.

Pokryskin, O. V. 1965. PROFILING OF A BLUNT CUTTER FOR BARKING FROZEN WOOD. Les. Zh. 8(4): 106-111.

Storgards, B., and Blomquist, B. 1967. TREE PROCESS SYSTEM ON THE SPOT. Pulp and Pap. 41(32): 30-31.
Sunds, AB, Sundsvall, Sweden, a subsidiary of the Swedish Cellulose Company, has developed and installed 15 portable limbing, slashing, and sorting devices that will accept trees up to 26 inches in diameter having branches up to 4 inches in diameter. One machine can delimb and buck 100 to 200 trees per hour. In eastern Canada, an average production of 65 to 70 cunits (a cunit is 200 cubic feet of chips) per hour shift was sustained for a month on trees that contained 5 cubic feet of solid wood each. In Sweden, on trees containing 10 cubic feet of solid wood apiece, the best performance has been 80 cunits per 8-hour shift. A 160-hp. diesel-generator set powers the unit. Limbs are cut ¼ inch from the stem by eight cylindrical cutters so arranged that they cover the circumference of the stem.

Swan, D. A. 1966. THE BRUNETTE BARKER. APA Tech. Release 66-R-23, 4 pp.
Describes a ring-type feed-through barker (manufactured by Carthage Machine Company, Carthage, New York) that incorporates means for controlling the pressure on the five abrader arms while the machine is running. The pressure on the abrader arms can be varied from zero up to practically any amount desired; the pressure may aslo be preset. Logs of any length and any diameter from 4 to 35 inches can be handled. Hardwood, softwood, and frozen wood have been successfully debarked.

Vogt, H. 1965. THE BARK'S ADHESION TO WOOD. Norsk Skogindustri 19(5): 181-186. (Also Can. Forest. Prod. Lab. Transl. 185.)
A method for determining bark adhesion to wood is described. Soaking in hot water reduced adhesion of spruce, pine, and birch bark and lowered debarking time. Frozen logs were easily debarked after soaking in 95° C. water. Any drying of logs increased adhesion of the bark. With a small barking drum, it was determined that bark adhesion increased rapidly during dry storage of wood. Steaming dry-stored or frozen wood for 10 minutes facilitated debarking. Barking time for birch was greatly reduced if the bark was torn before steaming. The time necessary to obtain a certain degree of barking for untreated, unfrozen logs was linearly dependent upon water content of the bark.

SAWING

GENERAL

Abeels, P. 1966. CONDUCT AND INTERPRETATION OF SAWING STUDIES. 30 pp. Centre Belge du Bois, St. Hubert, Belgium.

Abeels, P. 1967. FORMULATING AN EQUATION FOR THE SAWING OF WOOD. Agricultura 15(3): 127-132. Louvain.
Analyzes cutting force, and develops a formula taking into account chip thickness, depth of cut, tooth pitch, and number of teeth engaged. The experimental work was done on Picea abies *and* Fagus sylvatica.

Bygren, Floren, and Lidberg. 1966. (Safety, Including Noise)

Carruthers, J. F. 1967. RECENT RESEARCH ON SAWMILLS. J. Inst. Wood Sci. 18: 13-23.
Reviews recently completed research in sawmilling, and

tresses aspects of interest to the United Kingdom industry. Of major importance are investigations which may lead o an increase in the conversion factor, an improvement in awing accuracy, a reduction in the kerf width, and an ncrease in the productivity of mills.

Thardin, A. 1965. THE FUTURE OF SAWING IN FRANCE. Cah. ng. Agron. 198: 17-21.

Hallock, H. 1966. BETTER QUALITY STUDS BY FPL IMROVED SAWING METHOD. Southern Lumberman 212(2638): 7-19.

Describes the Forest Products Laboratory's method for sawng southern pine logs into 2 by 4's and 4 by 4's. Much of ne juvenile core is left in the central wedge of residue, nus reducing warping and increasing the amount of toprade studs.

Huvonen, K. 1967. THE INFLUENCE OF SAW KERF AND OVERMEASURE (ALLOWANCES FOR SHRINKAGE AND INACCURATE SAWNG) ON ECONOMY AND RECOVERY IN SAWMILLING OPERAIONS: STUDY BY DIGITAL COMPUTER. Paperi ja Puu 49(10): 661-670.

Kloss, R. 1965. CRITICAL OBSERVATIONS ON THE USE OF ERTICAL FRAME SAWS AND LOG BAND SAWING MACHINES IN ARDWOOD SAWMILLS. Holzindustrie 18(12): 337-340.

Koch, P. 1966. A SYSTEM FOR MANUFACTURING STRAIGHT TUDS FROM SOUTHERN PINE CORDWOOD. Southern Lumberman 213(2656): 165-169.

A process that appears to be economically feasible has been evised to convert 4-foot southern pine cordwood into nger-jointed, straight, 8-foot kiln-dry studs at the rate f one stud per second. Only bolts with diameters (inside ark) in the range from 4¼ inches to 6¾ inches are conerted (2.6 cords required per M b.f. of 2 by 4's). Studs ould be virtually 100 percent SPIB Stud grade and better. olts less than 4¼ inches in diameter are chipped, and olts 7 inches and larger are resold for conversion on lywood core lathes. Total investment for a plant, including 1,000,000 working capital, is estimated at $4,000,000. On two-shift basis, approximately 715 cords of rough bolts ould be consumed daily.

Koch, P. 1966. STRAIGHT STUDS FROM SOUTHERN PINE ENEER CORES. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-25, 7 pp. Southern Forest Exp. Sta., New Orleans, La.

Cores can be profitably converted into 8-foot 2 by 4's neeting strength and straightness requirements of Stud rade. Each core yields two studs. The sequence contemlated includes these steps: (1) diversion of 8-foot cores f 5¼-inch minimum diameter to the stud process, (2) enter ripping each core with a bandsaw, (3) reducing each reen half-log to uniform but oversize width and thickness n a chipping surfacer-edger, (4) uniformly kiln-drying the versize stud-blanks to 10-percent moisture content, (5) ace-jointing, thicknessing, and straight-line ripping the lanks, (6) double-end trimming, S4S planing, and edge narking, (7) spraying with preservative in wax emulsion vith dye, (8) cutting to special length, (9) sorting, and 10) shipping. To equip an existing plywood plant to proess cores into studs requires an estimated investment of 400,000, including working capital.

Koch, P. 1967. STRAIGHT STUDS ARE PRODUCED FROM OUTHERN PINE CORDWOOD. Forest Ind. 94(5): 44-46.

A process that appears to be economically feasible has been levised to convert 8-foot southern pine cordwood into traight, kiln-dry studs at the rate of 5,760 studs per day. Only bolts with diameters (inside bark) in the range from ¼ inches to 6¾ inches are converted. Southern pine n this diameter range probably averages less than four rings per inch. The specific gravity is lower than normal. The lumber warps severely during drying, since juvenile wood is always present and there is likely to be considerable compression wood. In conversion, warp is controlled by center-ripping the green bolt, then debarking the half bolts and blanking them oversize on a surfacer-edger that removes excess wood in the form of pulp chips. The oversize stud blanks are then uniformly kiln-dried to 10-percent moisture content, after which all distortion is removed by face-jointing and thicknessing, followed by straight-line ripping. Studs will be virtually 100 percent SPIB Stud grade and better. Total investment for a plant, including $100,000 working capital, is estimated at $425,000.

Kotesovec, V., and Zizka, J. 1966. FORMATION OF LONG CHIPS IN THE CUTTING OF PRISMS. Holz als Roh- und Werkstoff 25(8): 346-353.

Lundqvist, T. 1965. WHAT DOES DATA ON POWER SAWS MEAN IN THE PRACTICE? Jord och Skog 17(9): 27-31.

McCauley, O. D., and Whittaker, J. C. 1967. SAWMILL PRACTICES AND PROBLEMS IN THE APPALACHIAN HILL COUNTRY OF OHIO AND KENTUCKY. U. S. Dep. Agr. Forest Serv. Res. Pap. NE-80, 15 pp. Northeast. Forest Exp. Sta., Upper Darby, Penn.

Based on a study of 40 commercial sawmills in the forested hill country of Ohio and Kentucky, this report describes the mill types, their production practices, and their productivity, and attempts to identify the general problems related to milling efficiency. These problems are production delays —especially equipment failure—limited mechanization, poor record keeping, lack of standardization in log-grading systems used, and poor working conditions.

Makovskij, N. V. 1965. PRE-SELECTION SETTING OF WOODWORKING MACHINES. Les. Zh. 8(4): 151-161.

Describes experiments on preselection setting systems, tests on pulse mechanism and three electro-contact mechanisms, and the calculation of the economic feasibility of such systems.

Radu, A. 1966. THE QUALITY OF PROCESSED WOOD SURFACES AS AN IMPORTANT FACTOR FOR THE DETERMINATION OF OPTIMAL SYSTEMS OF SAWING IN THE MECHANICAL PROCESSING OF WOOD. Ind. Lemnului 17(3): 96-100.

Scheibeler, E. 1966. SAWING OF PULP AND BOARD. Papier Allgemeine Rundschau (11): 360.

Sima, P. 1966. CONSIDERATIONS ON THE CUTTING AND SAWING WOOD. Ind. Lemnului 17(12): 462-469.

Simons. 1966. (History and General Texts)

Thunell. 1967. (History and General Texts)

Vanhemelyryck, M. 1966. STUDY OF A TRANSIENT PHENOMENON OBSERVED WHEN MEASURING SAWING (POWER). Bull. Rech. Agron. Gembloux 1(2): 314-323.

Wilkins. 1966. (History and General Texts)

BANDSAWING

Anonymous. 1967. A BANDSAW WITH TWIN ROLLERS FOR SAW- AND SUPPORTING BANDS. Holz-Zentralbl. 93(29): 455.

Anonymous. 1967. (Research Instrumentation and Techniques)

Abeels, P. 1966. THE SAWING OF SPRUCE WITH A BAND SAW. 42 pp. Centre Belge du Bois, St. Hubert, Belgium.

Alexandru, S. 1966. STUDY OF THE FACTORS OF POWER WHICH INFLUENCE THE FEEDING SPEED OF BAND SAWS FOR CUTTING. Ind. Lemnului 17(8): 289-296.

Alexandru, Dogaru, and Tudor. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Doncev, G. 1965. EFFECT OF THE TOOTH GULLET IN BAND SAWS ON THE FEED SPEED, AND A NOMOGRAM FOR DETERMINING IT. Nauch. Tr. Lesoteh. Inst. 13: 253-258.
Develops a formula for feed per tooth, and presents a nomogram for determining feed in relation to gullet area.

Hemelryck, M. van. 1965. SAWING MEASUREMENTS. Lab. Forest. l'Etat. 19 pp. Gembloux.
Theoretical studies of variation in total vertical stress on the blade as a function of bite, variation in specific work, horizontal stress, and tensions in the blade.

Trubnikov. 1965. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Trubnikov. 1965. (Properties of the Cutting Edge and Cutter; Stability)

SASH GANGSAWING

Bajkowski. 1967. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Borovikov. 1965. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Duchnowski, K. 1966. INVESTIGATIONS ON THE LOAD ON SAW TEETH DUE TO CUTTING RESISTANCE. Przemysl Drzewny 17(11): 8-12.
Detail of a laboratory test-rig developed in Leningrad for measuring and recording the forces on frame-saw teeth.

Dumitrescu-girbovi, S. 1965. OPTIMAL FEEDING IN THE SAWING OF BEECH LOGS WITH GANG FRAME SAWS FROM THE POINT OF QUALITY OF CUTTINGS. Ind. Lemnului 16(5): 172-173.

Edamatsu, N. 1965. CHARACTERISTIC PROBLEMS IN SAWING WITH THE FRAME SAW. Wood Ind. 20(8): 2-5.

Gernet, G. M., Jur'ev, J. I., and Konovalov, V. A. 1967. DETERMINING THE FORCE RECEIVED BY THE SAW CARRIAGE AT THE MOMENT WHEN A LOG STRIKES THE ROLLERS OF THE FRAME SAW. Les. Zh. 10(1): 95-97.
A note describing a Soviet investigation in which wire strain-gauges were glued to the dogs.

Kafka, E. 1965. THE PROBLEM OF THIN SAW BLADES. Drevo 20(11): 385-389.
A detailed review of recent Soviet research and experience with thin (2 to 2.4 mm.) frame-saw blades.

Konoplev, P. S., and Potjarkin, L. P. 1967. CALCULATION OF THE RESISTANCE TO FEED INTO THE GUIDE APPARATUS OF A FRAME SAW. Les. Zh. 10(4): 96-101.

Kusian, R. 1966. THE INFLUENCE OF FORM AND SIZE OF CHIPS ON THE PROPERTIES OF PARTICLE BOARDS. Holztechnologie 7(1): 34-40.
When a gangsaw blade has a large tooth pitch, chip size and form are greatly influenced by the feed rate. Single-layer particleboards were made from gangsaw chips produced at feed rates of 6, 9, 12, and 16.5 mm. per cutting stroke. As feed rate increased, bending and tensile strength of the boards increased, and thickness swelling decreased slightly.

Lapin, P. 1967. IMPROVING THE WORK OF FRAME SAWS. Derev. Prom. 16(2): 1-4.
A review of Russian work on factors influencing the stability of frame-saw blades, especially the blade dimensions, roller tensioning, and stretching.

Lejhtling, K. A., and Smorgon, L. S. 1966. PREVENTING THE 'GUMMING' OF FRAME-SAW BLADE SURFACES WHEN SAWING LARCH. Lesnaya Prom. (11): 22-23.
Describes a device that sprays a fine mist of water and compressed air onto the blades, ridding them of the resin and simultaneously cooling them.

Malahov, I. K. 1965. DESIGN, CONSTRUCTION, MANUFACTURE AND USE OF FRAME SAWS. 438 pp. Izdatel'stvo 'Lesnaja Promyslennost'. Moscow.
A compilation of information on the classification of, and design calculations for, frame saws; the design and manufacture of Soviet frame saws (10 models); the design and manufacture of foreign frame saws (many models from 11 countries); and the use of frame saws (e.g., installation, preparation for work).

Ohara, M. 1965. GANG SAWS AND SAWING. PART I. Wood Ind. 20(9): 9-11.

Ohara, M. 1965. GANG SAWS AND SAWING. PART II. Wood Ind. 20(12): 14-17. (Translated by Joint Pub. Res. Serv., U. S. Dep. Comm., Wash., D. C. FPL-650. 1966.)
A high speed gangsaw of the AV-400 type, manufactured and sold by Akigi Industrial Company, can be fed continuously at speeds of 1.5 to 4 m. per minute. Saw blades are 0.058 to 0.032 inch thick.

Ostroumov, I. P., and Subina, N. P. 1966. IMPROVING THE QUALITY OF SAWING WOOD. Derev. Prom. 15(11): 26-28.
Details two devices for eliminating breaking out on the underside of cants passing through a frame saw.

Porter. 1965. (Properties of the Cutting Edge and Cutter; Stability)

Porter, A. W. 1966. DESIGN OF FRAME-SAW BLADES. New Zeal. Timber J. 12(11): 38, 41-42.
Scandinavian-designed frame-saw blades are compared with those of New Zealand and North America. Fourteen-gauge blades, similar to those used in Sweden, were tested. Tooth spacing was ⅛ to 1 inch, rake angle was 10°, and saws were swaged to nine gauge (0.148 inch). The Scandinavian blade should reduce kerf 25 to 35 percent for most large mills, increase feed rate 10 percent, decrease power consumption 15 percent, and greatly improve surface quality, while maintaining accuracy at present levels.

Porter, A. W. 1966. WAVY-EDGE SAWING BY FRAME SAWS. New Zeal. Timber J. 12(8): 48-50.
On a gangsaw, wavy-edge lumber may result from two distinct causes. The first is transverse log displacement, which results in a duplicate wavy pattern on both sides of a board. This trouble is minimized by eliminating all end play in the feed rollers, providing feed rollers with a flat or slightly convex surface, and placing the log on the carriage so that bumps or irregularities will not come in contact with the feed rollers, but will be removed with the first slabs. The second major cause of wave patterns is saw displacement resulting from loss of mounting tension on one or both of the two center saws in the sash. Wave formations on opposite sides of a board then tend to be dissimilar. In this study, a saw tension maintained at 13,300 pounds eliminated wave formation. This value is comparable to the range used in Sweden, i. e., 11,000 to 17,000 pounds.

Postnikov, A. 1966. COMPARATIVE TESTING OF FRAME SAWS WITH SPRING-SET AND SWAGED TEETH. Pregl. naucnoteh. Rad. Inform., Zavod Tehn. Drveta, Sarajevo 3(2/3): 15-35.
A detailed study made during commercial sawings of beech

nd fir, and covering the rate of tooth blunting, vibrations, lade temperatures, sawn surface quality, and power consumption. Swaged teeth were superior to spring-set teeth.

Potjarkin, L. P. 1965. KINETOSTATIC CALCULATION ON RAME SAWS HAVING A STROKE OF 600 TO 700 MILLIMETERS. es. Zh. 8(3): 113-120.
resents a graphic method of determining the forces acting n frame saws, and tabulates data on inertia forces and ressures for 24 different positions of the crankshaft in two f the commonest Soviet frame saws, the RD 75-6 and the D 80-1.

ivak, M. 1966. TO SPRING-SET OR TO SWAGE THE TEETH OF RAME SAW BLADES? Drevo 21(3): 82-87.
dvantages and disadvantages of the two setting methods, n the light of recent Northern European and Soviet research.

obolev, I. V., and Sotikova, L. G. 1967. THE EFFECT OF EED ON THE QUALITY OF FRAME SAWING. Les. Zh. 10(2): 13-117.

hunell, B. 1966. THE EFFECT OF FEED AND BLADE THICKESS ON THE ACCURACY OF FRAME SAWS. Holz als Roh- und Verkstoff 24(10): 516-520.
n frame sawing, deviations increased slowly but constantly ith rising feed rate. Beyond a certain rate, loss of staility caused a rapid increase in deviation. The limiting eed rate was influenced by, among other factors, blade hickness and cutting depth.

hunell, B., and Wallin, G. 1966. INFLUENCE OF SAWING ONDITIONS ON CUTTING FORCES IN FRAME SAWING. Paperi a Puu 48(12): 751-753, 755-758.
eed (in millimeters per stroke) greatly influenced frame awing forces in all positions of the crankshaft. Overhang ercentage seemed to be of minor importance. Sawing orces were minimum at approximately 0.5 to 0.6 mm. for et teeth and at 0.6 to 0.7 mm. for swaged teeth. Temperaure of the wood was highly significant, especially when he frame moved upward; peak forces increased in frozen ood. The full effect of freezing was not evident until -15 to —20° C. was reached.

Thunell and Wallin. 1966. (Research Instrumentation nd Techniques)

Thunell, B., and Wallin, G. 1967. EFFECT OF KNOTS ON HE CUTTING FORCES IN FRAME SAWING. Paperi ja Puu 49(2): 1-73.
revious investigations established that the cutting forces n frame sawing vary considerably with the quality of he wood. An extensive study showed two of the most nportant factors to be the amount of knots and the presnce of compression wood. Some cutting-force records are hown for material with and without defects of these two ypes. The increase in the forces rises up to 100 percent ven for moderate knots and is 50 percent for some streaks f compression wood.

Windelbandt, H. 1966. THE SWINGING FRAME OF THE GANG AW AS A MEANS OF ADJUSTING TO CONTINUOUS FEED. Holzentralbl. 92(32): 635-636.
n normal practice the frame is inclined towards the feed irection of the log, so that clearance is obtained on the pward stroke of the saws, and higher feed speeds (up to 0 f.p.m.) can be obtained. The article describes an alterative mechanism whereby the frame is given a combinaion of a rotary and a reciprocating motion, to obtain ncreased clearance on the upstroke of the saws, and thus ermit even higher feed speeds.

Wuster. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Yoshida, N. 1965. THE STRUCTURE OF GANG SAWS. (III). Hokkaido Forest Prod. Res. Inst. J. 14(162): 15-16.

CIRCULAR SAWING

Anonymous. 1966. THE SHORT LOG BOLTER. Northern Logger 14(8): 18-19, 30.
Short log bolters are most efficient on material 7 to 16 inches in diameter, but addition of a topsaw permits cuts as deep as 23 inches, so that bolts with diameters up to 30 inches may be sawn. According to one manufacturer of bolters, average productivity on bolts 52 inches long is 11 cuts per minute, including slabbing. Some users report an average as high as 15 cuts per minute. The manufacturer states that, when birch and maple are sawn to thicknesses of 1/16 to 1½ inches, production of 4,600 board feet (9¼ cords) per 8-hour shift is possible; on 3- to 5-inch stock, comparable figures are 9,000 board feet (18 cords) per shift.

Ablamowicz-ledwon. 1965. (Properties of the Cutting Edge and Cutter; Stability)

Barz. 1965. (Properties of the Cutting Edge and Cutter; Stability)

Barz and Hoptner. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Bershadskii, A. 1966. CALCULATING PARAMETERS FOR RIPSAWING. Lesnaya Prom. (12): 8-13. (CSIRO transl. 7748.)

Booth and Sulc. 1966. (Properties of the Cutting Edge and Cutter; Tool Material)

Demsky, S. 1967. MERITS OF THE KLEAR-KUT SAW. *In* Twenty-Second Annu. Northwest Wood Prod. Clin. Proc. 1967: 33-35. Spokane, Wash.
Thin circular saws tend to be distorted by heat generated by friction between saw plate and kerf wall. The Klear-Kut saw has cutters riveted to the sides of the saw plate, so as to form a solid cutting line from saw gullet to collar. The cutting edges extend out from the plate about one half the distance to the set points of the teeth. These edges cut the sides of the plate free whenever saw deflection occurs. Slots punched along the leading edges of the cutters allow chips to escape to the opposite side of the saw plate.

DuClos, A. 1967. THIN KERF SAWING. *In* Twenty-Second Annu. Northwest Wood Prod. Clin. Proc. 1967: 37-42. Spokane, Wash.
To minimize kerf when edging lumber with circular saws it is desirable to reduce saw-plate friction (with side cutters using the Klear-Kut principle) and keep the effective rake angle fairly large. Diagrams show that a conventional 24-inch edger saw with 40° rake angle has a negative effective rake when the teeth enter the top of a 6-inch cant. By contrast, the buried saws of a double-arbor edger (top saw climb-cutting) have a satisfactory positive effective rake angle even on 12-inch cants. Recent progress now permits the manufacture of carbide saw teeth having a rake angle of 40°. These teeth applied to Klear-Kut saws mounted on a 12-inch double-arbor edger show promise of accomplishing thin-kerf sawing.

Fukui, H. 1962. STUDIES ON SAWING WOOD WITH CIRCULAR SAWS, PARTICULARLY ON ROUGHNESS OF SAWN SURFACE. Univ. Educ. (Fac. Agr.) No. 8, pp. 217-297. Tokyo.
Discusses the profile of surfaces cut by a circular saw; the effect of feed speed, speed of saw rotation, radius of saw, tooth angles, cutting direction, and size of raker teeth (combination saws) on surface roughness; and the effect of face and top bevel angles on power consumption.

Fukui, H. 1965. SOME PROBLEMS IN THE MECHANICS OF CIRCULAR SAWING. PART II. Wood Ind. 20(12): 18-23.

Fukui, H. 1967. THE FACE (FRONT) BEVEL ANGLE (THETA-F) OF CARBIDE-TIPPED SAWS. PART II—RELATIONS OF THETA-F TO QUALITY OF SAWN SURFACE. Wood Ind. 22(242): 14-17.

Fukui, H., Hara, O., and Sato, S. 1965. BREAKING TEST OF THE EDGE OF PLYWOOD AT THE TRIMMING SAW BY A BREAK-UP SAW (CIRCULAR SAW TYPE BREAK-UP TOOL). Wood Ind. 20(5): 17-23.
A circular breakup saw and circular trim saw fixed on the same saw spindle were used in breaking tests of the edge of plywood. Two types of breakup saw were used. One was a Y type having hook angle (rake angle) of 15°, sharpness angle of 62°, clearance angle of 13°, top and face bevel angles of 0°, 40 teeth, and maximum diameter of 30.5 cm. The other was an S type having rake angle of 9.5°, sharpness angle of 32°, clearance angle of 48.5°, top and face bevel angles of 0°, 40 teeth, and maximum diameter of 30.0 cm. Three-ply lauan plywood 3 mm. thick was stacked in piles of 8 sheets and sawn parallel to the grain direction of the face veneer. The position of the breakup saw on the machine made corner tearout common. Width of corner tearout increased with increased width of the edge to be broken up; supporting the edge of the panel reduced corner tearout. The trimmed surface was best with the S-type breakup saw. Top-beveling (15°) the teeth of the S-type saw reduced the corner tearout.

Gill. 1965. (Properties of the Cutting Edge and Cutter; Temperature)

Glijer. 1967. (Properties of the Cutting Edge and Cutter; Temperature)

Grigorov, P. 1965. DETERMINATION OF THE SHAPE AND DIMENSIONS OF A DRUNKEN SAW, AS A FUNCTION OF THE PROFILE OF THE WORKPIECE. Nauch. Tr. Lesoteh. Inst. 13, pp. 295-306.
Elliptical drunken saws are being used for rounding off pieces in a Bulgarian sports-goods factory. The mathematical theory of cutting with such saws is explained, and tables are constructed to assist calculation of saw dimensions for cutting convex and concave profiles. Such saws are claimed to possess a number of advantages over molding cutters.

Grin'kov. 1967. (Safety, Including Noise)

Iliev, Filipov, and Sehtov. 1967. (Machinability of Lumber and Particleboard)

Jakunin, N. K. 1960. RIPSAWING HARDWOOD ON CIRCULAR SAWS. Derev. Prom. (3): 11-13; (4): 9-12.
Discusses the influence of clearance and rake angles on power parameters; the effect of the number of teeth on energy dissipation and surface finish of the cut; and maximum feed per tooth and thickness of chip for a good surface when ripsawing hardwoods.

Jones, D. S. 1966. A STUDY OF SWAGE-SET CIRCULAR SAWS CUTTING SOFTWOOD. Australian Timber J. 32(5): 41-44.
Green, 4- and 6-inch-thick cants of Pinus radiata *were ripped into boards with circular saws turning at 1,100 r.p.m. Blades were 27⅝ inches in diameter, rake angle was 30°, and feed speed was 200 f.p.m. Under these conditions, 40-tooth swaged saws used less power (21 hp. for 4-inch cants and 35 hp. for 6-inch cants) and sawed more accurately than spring-set or swage-set saws with 54 teeth.*

Jones, D. S. 1966. THE DESIGN OF PLYWOOD TRIM SAWS. Australian Timber J. 32(3): 47, 51, 53-55.
A good plywood trim saw should have climb-sawing arrangement with positive roller or caterpillar feed. Minimum penetration of the saw through the workpiece is desirable. For cross-cutting veneers, teeth with both front and top bevel are best. Suitable angles for steel or hard metal alloy teeth are about 15°; for tungsten carbide tips, side bevel angle can be as low as 5° with front bevel up to 15°; sharpness angles should be not less than 45°. Rake angle should be close to 0° (positive for climb-sawing and low or negative for counter-sawing). Saw rim speed should be at least 10,000 f.p.m. Carbide tipped saws should carry 30 to 60 teeth. Steel saws should be chrome-plated, side-dressed, and hollow-ground. Vibrations should be minimized by avoiding critical spindle speeds, employing slotted saw blades, balancing and servicing hogging cutters, and by using collars of large diameters.

Malcolm, F. B. 1967. COARSE FEED SAWING OF RED OAK—A LIMITED STUDY. U. S. Forest Serv. Res. Note FPL-0155, 16 pp. Forest Prod. Lab., Madison, Wis.
Red oak was sawn with bites (log feed in inches during one revolution of the saw divided by the number of teeth in the saw) of ⅛, 3/16, and ¼ inch. Results resembled those from coarse-feed sawing of southern pine. The ⅛-inch bite was superior in saw performance when edge tearout was included in the analysis; otherwise the 3/16-inch bite was superior. Yield tended to be less at ¼-inch bites than at ⅛ and 3/16 inch. Residual kerf on the board reduced volume of ⅛-inch bite about 3 percent, of the 3/16-inch bite 5 percent, and of the ¼-inch bite about 10 percent. Pulp made from sawdust of ¼-inch bite and pulp from conventional ⅝-inch chips had similar strength. Pulp of sawdust from ⅛- and 3/16-inch bites was weaker.

Nakamura, G. 1967. EFFECT OF ROTATION OF SAW SPINDLE TO CUTTING FORCE IN CIRCULAR SAWING. J. Jap. Wood Res. Soc. 13(6): 232-237.
Two- and four-tooth circular saws approximately 10 inches in diameter and having spring-set teeth with 10° rake angle were used to rip red lauan (Shorea *spp.) 24 mm. thick and 14.5 percent in moisture content. Feed speed was 5 m. per minute. For a saw 255 mm. in diameter, total torque in kg.-cm. was equal to* $(12\ n^{1.81})(10^{-7}) + 8{,}896\ n^{-0.83}$; *where* n = *r.p.m. of saw. The first term in the equation is the idling torque and the second term the torque due to cutting. If this formula is differentiated to solve for minimum torque, the desired r.p.m. of the saw is 4,080.*

Olszewski. 1965. (Properties of the Cutting Edge and Cutter; Tool Material)

Olszewski. 1967. (Machinability of Lumber and Particleboard)

Pahlitzsch and Rowinski. 1966, 1967. (Properties of the Cutting Edge and Cutter; Stability)

Stahiev. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Stahiev. 1967. (Properties of the Cutting Edge and Cutter; Stability)

Tverdynina. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Wuster. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Yamaguchi and Aoyama. 1962. (Properties of the Cutting Edge and Cutter; Tool Material)

Zajcev and Smolin. 1967. (Properties of the Cutting Edge and Cutter; Dulling)

CHAIN SAWING

Anonymous. 1966. (Properties of the Cutting Edge and Cutter; Fitting and Sharpening)

Axelsson, S. A. 1967. AN ANALYSIS OF CHAIN SAW VIBRATIONS. Rapp. Uppsatser Inst. Skogsteknik Skogshösk No. 31, 95 pp. Stockholm.

Clippert. 1965. (Safety, Including Noise)

Fujii, Y., Sugihara, H., and Suzuka, M. 1967. STUDY ON WOOD CUTTING ABILITY OF SINGLE CHAIN-SAW TOOTH. II. J. Jap. Forest. Soc. 49(1): 1-8.
Discusses energy consumption as affected by saw-tooth angles.

Gambrell, S., and Byars, E. 1966. CUTTING CHARACTERISTICS OF CHAIN SAW TEETH. Forest Prod. J. 16(1): 62-71.
A whirling-arm cutting apparatus of variable velocity was devised. Cutting forces (measured on a tool dynamometer) and energy consumption were observed at speeds of 500 to 3,640 f.p.m. in cuts 0.010 to 0.060 inch deep with simultaneous photos of chip formation. The three principal cutting forces increased with increasing speed. Energy consumption was relatively independent of cutting angle. The planing component of the longitudinal force produced the greatest energy consumption. Chip formation was dependent upon depth of cut and independent of cutting speed.

Julich, L. 1965. ON THE CONSTRUCTION OF A BENCH FOR THE TESTING OF POWER CHAIN SAWS. Arch. Forstwesen 14(11/12): 1201-1221.
Through two gears a 7 kw. electric motor drives a shaft on which exchangeable sawing assemblies of different power-saw types can be mounted. Wood can be clamped fast or swung in a circle against a stationary sawing mechanism. The method of ascertaining main parameters is based on (1) an indirect effect measured by evaluation of power intake of the electric motor and (2) the ratio of electric intake to mechanical effect delivered on the driving sprocket; this ratio is determined by braking the entire testing apparatus.

Kato and Ohsato. 1965. (Safety, Including Noise)

Makoveev, P. 1965. SAW CHAINS FOR POWER SAWS. Lesnaya Prom. (11): 4-6.

Nikolic, S. 1965. A CONTRIBUTION TO THE STUDY OF BLADES AND ELEMENTS OF SHARPENING OF CHAINS OF POWER SAWS. Sum. List 89(1/2): 30-38.

Oehrli, J. W. 1960. DYNAMOMETER TESTS ON CUTTING ACTION OF CHAIN-SAW TEETH. Forest Prod. J. 10(1): 4-7.
Cutting was done with chain-saw cutters fixed on a 38-inch saw disk driven by an accurate dynamometer with stable speed control. An optimum bite was shown for each type of cutter regardless of wide variations in cutting-tooth velocity, feed rate, and power available. Cutting efficiency decreased with small bites and approached zero with an infinitesimal bite. Vibration, which changed the path of the cutter, was extremely wasteful of power. Chain-cutter action was affected by the mass of the supporting bar. Effect of kerf width on cutting efficiency varied greatly with bite. Feed pressure requirements were much lower with moderately high cutting velocity.

Pahlitzsch, G., and Peters, H. 1966. INVESTIGATIONS ON THE CUTTING WITH CHAIN SAWS. PART I—THE INFLUENCE OF WOOD MOISTURE CONTENT, CUTTING DIRECTION AND FEED RATE ON CHAIN SAWING. Holz als Roh- und Werkstoff 24(2): 59-71.
Commercial scratch-type and chipper-type chains were used in investigations with pine, poplar, and beech. With the scratch-type chain, total cutting and feed force were maximum at about 17 percent wood moisture content; with the chipper-type chain, at 10 percent. Absolute values of the cutting and feed forces with the chipper-type chain were 40 percent and 50 to 70 percent, respectively, below those of the scratch-type chain. In all cases cutting and feed forces for edging exceeded those for cross-sawing by 65 to 170 percent. Chipper type chains were superior to scratch-type chains for edging. With a scratch-type chain at an angle between longitudinal and cross-cutting, cutting and feed forces increased as the angle became more obtuse; with the chipper-type chain, the forces decreased. With both types of chains, cutting force increased progressively and feed force linearly when the feed rate was increased.

Popescu, Teodoreseu, and Senchea. 1966. (Safety, Including Noise)

Statkov, N. 1964. STUDIES ON THE DETERMINATION OF THE SPECIFIC WORK IN CROSS-CUTTING SOFTWOOD WITH CHAIN SAWS. Nauch. Tr. Lesoteh. Inst. 12: 219-229.

Szepesi. 1965. (Properties of the Cutting Edge and Cutter; Stability)

MACHINING WITH HIGH-ENERGY JETS

Anonymous. 1966. WATER JET WILL CUT ALMOST ANYTHING. TAPPI 49(11): 26A. *See also* Wood and Wood Prod. 71(12): 84-85.
A water jet 0.005-inch thick and traveling three times the speed of sound cuts wood and other material. The jet, developed at the University of Michigan, is operated with a water pressure of 50,000 pounds per square inch and a flow rate of about 40 gallons per hour. It has cut concrete 1-inch thick at a rate of 15 inches per minute, 55 layers of cotton nylon fabric (a stack 2 inches high) at 150 inches per minute. New equipment provides water pressure of 100,000 to 400,000 pounds per square inch and flow rate of a few hundred gallons per hour and theoretically will cut through 20 inches of concrete. The liquid jet has advantages of speed, flexibility, low waste, and elimination of tool wear. In lumber, the area of the cut is a few hundredths of an inch thick. At present, the liquid jet has equipment limitations and research is aimed at improving nozzle design and overcoming pressure problems with flexible couplings.

MACHINING WITH LIGHT

Kinoshita, N., and Arai, T. 1967. WOOD WORKING BY LASER BEAM. Wood Ind. 22(6): 17-21.
A study of the factors (power and width of beam, wood section, moisture content) affecting the volume and depth of holes bored in wood by a laser beam.

SHEARING

des Champs, J. 1967. TREE SHEAR LOPS 15% OFF FELLING. Can. Forest Ind. 87(7): 64-67.
The $7,000 tractor-mounted Roanoke Tree Shear, manufactured by Harrington Manufacturing Company, Inc., Lewiston, North Carolina, was tested in central British Columbia. The cutting jaws on the hydraulic tree shear have an opening of 37 inches at the tips, close in 7 seconds, and can efficiently fell trees up to 30 inches in diameter. Stems are felled perpendicular to the tractor's line of travel. In the test, stands varied from dense to open; terrain conditions included mud, swamp, and deep snow (with

frozen timber), steep ground, and flat ground; species considered were pine, spruce, and hemlock. Average felling rate achieved over a study period of 3 months was 100 trees per hour in dense stands with trees averaging 16 inches in diameter at the butt. In open stands the average climbed to 115 trees per hour. Trees averaged 18 to 20 cubic feet each. In comparison to manual felling, costs were reduced 15 percent, production per man was increased 100 percent. Sheared trees yielded a 5-percent greater volume of chips than sawed trees.

Jackson, W. L. 1967. MECHANICS OF JACKSON'S CONTINUOUS LOG SHEAR DESCRIBED BY INVENTOR. Amer. Pulpwood Assoc. Tech. Pap. 66-45, pp. 6-7.
After making tests of a truck-mounted working model, the Head-Jackson Equipment Company of Pensacola, Florida, is building a continuous log shear designed for permanent installation in a pulpmill yard. The design calls for a pair of vertical wheels which counter-rotate in the manner of meshed spur gears. Logs are fed longitudinally between the wheels. The wheels measure 20 feet in diameter and four knives are mounted at equal intervals on the perimeter of each. Knives in the top and bottom wheels are timed to coincide and each cuts halfway through the log. Thus long logs are sheared into 5-foot lengths. The wheels will operate at a maximum of 15 r.p.m., to yield 300 lineal f.p.m. On 14-inch logs the stated capacity is 90 cords per hour. Maximum admissable log diameter will be 20 inches. The wheels will be driven by hydraulic motors. Total power required will be as much as 500 hp. but will depend on production required.

Kempe, C. 1967. FORCES AND DAMAGE INVOLVED IN THE HYDRAULIC SHEARING OF WOOD. Studia Forest. Suecica No. 55, 38 pp. Roy. Coll. Forest., Stockholm, Sweden. Translated by M. J. Larsson, Univ. New Brunswick.
Fresh squared spruce specimens 7 to 18 cm. wide and 7 to 14 cm. high were sheared perpendicular to the grain with a guillotine-type tool. Knife thickness ranged from 5 to 10 mm. with wedge angles from 30 to 60°. Cutting speed varied from 5 to 20 cm. per second. Wedging, shearing, and frictional forces as well as damage to the workpiece (cracking, splitting, etc.) were determined when shearing warm and frozen wood. A knife with thickness of 5 mm. and a wedge angle of 45° is proposed. Cutting speed had no significant effect on force requirements. Knots increased the shearing force up to 50 percent. The sharpness of the edge is probably of minor importance. Cutting force for frozen wood was from 15 to 50 percent more than in warm wood. Friction force was somewhat more for warm than for frozen wood. Tangential 90-90 cutting (cutting across the grain but parallel to the annual rings) required 20 to 30 percent greater cutting force than radial 90-90 cutting (cutting direction across the grain but perpendicular to the annual rings). Damage to the wood was minimized by using thin, sharp knives with a low wedge angle.

JOINTING, PLANING, MOLDING, AND SHAPING

Anonymous. 1966. STRAIGHTLINER IN PRODUCTION. Southern Lumberman 212(2634): 34.
The Straightliner, manufactured by Hycalog, Inc. of Shreveport, Louisiana, is designed for straightening warped or crooked boards. A machine has been successfully operated for a year at the Martin Timber Company, Castor, Louisiana. All dunnage or low grade lumber is fed through the upgrading station. The machine upgrades lumber at a calculated average of 75 percent No. 2 and 25 percent No. 1 and better, with 17 percent loss of board footage. It has no fence but a special type of chain. Heads have a 23-inch cutting circle and exert no side pressure on the lumber. The Straightliner is reported to be able to joint a board on one side and take a 4-inch cut on the other side without any side movement. An attachment can be used for ripping a 2 by 8 into two 2 by 4's or a 2 by 6 into two 2 by 3's for interior studding.

Anonymous. 1966. THE EFFECTS OF MOISTURE CONTENT WHEN PLANING AND MOULDING WOOD. Timber Res. and Develop. Assoc. Adv. Serv. Leafl. 21, 12 pp.
Summarizes world literature on the subject.

Anonymous. 1967. (Safety, Including Noise)

Alekseev. 1967. (Properties of the Cutting Edge and Cutter; Dulling)

Carruthers, J. F. 1967. THE MACHINE PLANING OF HARDWOODS. Forest Prod. Res. Bull. 51, 4 pp.
Summarizes information from extensive woodcutting trials at Princes Risborough on feed speed, cutter speed, and cutting angle, and assigns 50 hardwoods commonly used in Britain to three cutting-angle groups (30, 20, and 15°) and three blunting grades.

Goodchild, R. 1967. FACTORS AFFECTING THE POWER USED IN PLANING. Woodworking Ind. 24(7): 28-29.
The electrical power taken by the motors driving the cutter blocks increases with feed speed, depth of cut, and cutting speed, but generally the increases in the power are small in relation to changes in these variables. The power also increases as the cutting angle is reduced and as the width of the heel caused by jointing becomes greater.

Jain, N. C., and Rawat, B. S. 1966. STUDIES OF THE SURFACE FINISH OBTAINED IN PLANING INDIAN TIMBERS. Woodworking Ind. 23(3): 31-32.
The testing apparatus is essentially a cylinder, placed over the planed wood specimen, in which the rate of fall of a vacuum, produced by a pump, is used to indicate the smoothness of the wood. A table shows the observed "smoothness factor" thus obtained for 15 Indian hardwoods. Correlations of the "smoothness factor" with specific gravity, hardness, and tension perpendicular were not significant statistically.

Morris, P. H. 1966. DEVELOPMENT OF PLANING AND MOULDING MACHINES. Woodworking Ind. 23(6): 26-28.
Reviews developments which improve the volume or quality of the work done. Topics include methods enabling higher feed speeds, techniques of straightening stock, feeding of tenoned stock into molding machines, and future trends in planing and molding machines.

Pahlitzsch, G. 1966. AN INTERNATIONAL REVIEW ON RESEARCH IN THE FIELD OF PLANING AND MILLING OF WOOD AND WOOD-BASE MATERIALS. Holz als Roh- und Werkstoff 24(12): 579-593.
Discusses tools and procedures for cutting and planing, nomenclature standardized in Germany, chip formation, and factors affecting power demand. Considers wear of cutters, cutter temperature, surface quality, and development of noise. Twenty-two references are cited. Few English-language references were included.

Pahlitzsch and Jostmeier. 1966. (Machinability of Lumber and Particleboard)

Trokes, S. 1965. EFFECT OF CERTAIN CONDITIONS ON THE BREAKING OUT OF CHIPS IN SPINDLE-MOULDING ACROSS THE GRAIN. Drevarsky Vyskum 3: 179-190.
Determines the effect of grain direction, direction of annual rings, feed per cutter, cutting angle, blunting, and depth of cut on the breaking out of chips.

Dietz, R. C., and Jenson, J. A. 1966. PRESURFACING GREEN OAK LUMBER TO REDUCE SURFACE CHECKING. U. S. Forest Serv. Res. Note FPL-0146, 1 p. U. S. Forest Serv. Forest Prod. Lab., Madison, Wis.
Surface checking is minimized by presurfacing or "blanking" green wood prior to kiln drying. Tension stresses on drying surfaces are uniformly distributed over the surface and not concentrated at weakened areas.

Filina, G. 1966. REGULATION OF FEED SPEED IN MACHINES FOR CONTOUR WORKING OF WOOD PANELS. Les. Zh. 9(4): 108-112.
Discusses the advantages of having a fast, constant feed speed for the nonworking part of the line and a variable speed for the working part. Describes the development of such a feed system in the USSR.

Strickler, M. D. 1967. IMPRESSION FINGER JOINTING OF LUMBER. Forest Prod. J. 17(10): 23-28.
Impression finger jointing is a new method of end-gluing lumber that employs a heated die (approximately 500° F.) to form joint ends. The die-forming operation, generally done in 5 seconds or less, develops densified fingers with parallel-grain surfaces. Fingers are very short (a minimum of wood waste) and fingertips are thinner than in conventional machined joints. If the end joints are glued immediately after they are formed, residual heat from the finger impression cures a thermosetting adhesive quickly. Pilot-scale research has demonstrated the feasibility of combining impression finger jointing with a preshaping operation for producing high-strength end joints uniformly in Douglas-fir and western larch. Such joints meet the most stringent code requirements for strength of structural end joints. In addition, satisfactory end joints may be produced without preshaping in low-density softwoods for applications in which maximum joint strength is not required.

Vinogradov, V. A. 1966. IMBALANCE OF THE CUTTING TOOL OF A SPINDLE-MOULDER, AND THE MICROGEOMETRY OF THE MOULDED SURFACE. Les. Zh. 9(1): 94-99.
Investigation of the effect of tool imbalance on the bending of the conical part of the spindle indicated that the inertia forces caused by the imbalance act statically on the spindle. The effect of the tool's imbalance on the microgeometry of the worked surface was therefore analyzed on the basis of the static rigidity of the spindle and of its conical part. Contains a graph from which any limiting values of tool imbalance can be determined at a particular speed when producing a surface of a given quality class.

Wacker, H. 1967. MODERN PLANING MILLS. Holz als Roh- und Werkstoff 9(9): 329-348.
The structure, layout, and material flow of a planing mill are described. Fixed-knife planing machines are described in detail. The author concludes that in the last 30 years practically no revolutionizing innovations have been made in planing mill technique, but that the modern planing mill meets today's requirements because of refinement in planing techniques. A literature review is included.

TURNING

Bergin. 1966. (Properties of the Cutting Edge and Cutter; Dulling)

Galinkin, B. E., Bendin, A. S., and Kozevnikov, B. I. 1965. A STUDY OF SURFACE ROUGHNESS IN TURNING COMPRESSED WOOD. Derev. Prom. 14(11): 7-9.
Discusses tests on the effect of cutting-regime variables upon the surface roughness of cylinders made from birch compressed in one direction and bushings made from contour-compressed birch. Cutting speed and depth had little effect, but surface smoothness could be improved by reducing the rate of feed. Optimum surface quality was achieved by using the maximum cutting speed for the particular machine and a feed not greater than 0.3 mm. per revolution.

Galinkin, B. E., and Kozevnikov, B. I. 1965. INVESTIGATION OF THE DYNAMICS OF THE CUTTING PROCESS IN TURNING COMPRESSED WOOD. Les. Zh. 8(1): 96-100.
The relation of the components of the cutting force to depth of cut, feed speed, and cutting speed was determined in turning compressed birch wood. Cutting force was 40 to 70 kg. which, at cutting speeds of 200 to 300 m. per minute, required 2 to 3.5 kw. The use of metal-working lathes appeared desirable. Cutting speeds should be the maximum that the machine is capable of, and feed speeds should be as high as possible, consistent with surface quality. For practical calculations, the tangential component of the cutting force (in kilograms) equals $(7.05\ S + 2.67)t - 0.107$, where S is feed in millimeters per revolution and t is depth of cut in millimeters.

Koch. 1967. (Chipping, Flaking, and Grinding; Chipping Headrigs and Edgers)

BORING, ROUTING, AND CARVING

Pahlitzsch and Jostmeier. 1966. (Properties of the Cutting Edge and Cutter; Dulling)

MORTISING AND TENONING

Hoshi, T., and Mori, M. 1963. EFFICIENCY OF END JOINTS IN MIZUNARA. Government Forest Exp. Sta. Bull. 153, pp. 73-93. Tokyo.
Bending and tensile strengths were determined for plain scarf, square-toothed scarf, and finger end joints in mizunara.

Strickler. 1967. (Jointing, Planing, Molding, and Shaping)

MACHINING WITH COATED ABRASIVES

Anonymous. 1967. (History and General Texts)

Holland, C. J. 1966. THE CHANGING FACE OF WOOD SANDING. Wood and Wood Prod. 71(4): 34, 36.
Resin-bonded abrasives, the serrated contact wheel, and through-feed wide-belt machines are three main developments in wood sanding. Use of resin-bonded abrasives has expanded rapidly because increased useful life exceeds any increase in cost. Resin-belt papers on a stroke sander were used for 16 to 32 hours compared to 4 to 6 hours for glue-bonded belts. Resin-bonded garnet or aluminum oxide X-weight cloth belts on an edge sander had three times longer useful life than glue-bonded belts. Besides longer useful life, resin-bonded products have greater heat resistance, maintain a clean cutting action longer, resist loading, and are less susceptible to humidity. Disadvantages of resin-bonded abrasives are lack of flexibility, harsher cutting action, and coarser scratch pattern. Resin-bonded products should not be used on wood having high pitch content, for final polishing of prefinished panels, or where working pressures are low and little heat is generated. Serrated contact wheels having narrow lands separated by open grooves produce four times more effective grinding pressure than plain contact wheels with the same pressure on the workpiece. They also reduce loading or clogging and are cooler running. Through-feed, wide-belt machines are being used by plywood and particleboard plants at feed rates as high as 200 f.p.m. with 0.100-inch stock removal. A combination of through-feed, wide-belt machines with pneumatic platen units reduces abrasive costs in cutdown and polishing operations.

Ljubimov, V. 1966. SANDING THE EDGES OF PLYWOOD WITH ABRASIVE DISKS. Derev. Prom. 15(8): 7.
Describes successful tests of the disks (made of comminuted glass plus liquid and powdered bakelite) in sanding the edges of various kinds of birch plywood.

Nakamura, G. 1966. STUDIES ON WOOD SANDING BY BELT-SANDER. (II)—INDUSTRIAL TEST OF PLYWOOD SANDING BY WIDE BELT-SANDER. Tokyo Univ. Agr. and Technol. Exp. Forest. Bull. 5, pp. 1-17.
A 50 hp., top-cutting, single-belt abrasive sander was used; belts were 129 cm. wide and 264 cm. long. Aluminum oxide on paper backing was tested in grit sizes of 80, 100, 150, and 180 mesh. Silicon carbide on cloth backing was tested in grit of 240 mesh. The serrated rubber contact roll was 46.5 cm. in diameter and turned at 1,050 r.p.m. The feed roll (immediately below the contact roll) was 25 cm. in diameter and could be adjusted to give a stepless range in feed speeds from 20 to 70 m. per minute. While the sander had a platen following the contact roll, it was withdrawn so that only the contact roll was in action. Plywood tested was of three species: lauan (Shorea *sp.), sen* (Kalopanax *sp.), and makamba* (Betula *sp.). Results were as follows:*

1. *Stock removal (grams per minute) was inversely proportional to feed speed. In the range from 20 to 50 m. per minute the slope of the curve was steep; in the range from 50 to 70 m. the curve flattened somewhat. Stock removal rate was less influenced by feed rate when belts were of fine grit than when they were of coarse grit.*
2. *Required belt power increased linearly with rate of stock removal.*
3. *Required belt power was proportional to belt velocity and to the force applied by the contact roll.*

Pahlitzsch, G., and Dziobek, K. 1962. DETERMINING QUALITY OF MACHINED WOOD SURFACES. PART II—EFFECT OF OPERATING CONDITIONS ON QUALITY OF SANDED BOARD SURFACES. Holz als Roh- und Werkstoff 20(4): 127-137. (Translated by Joint Pub. Res. Serv., U. S. Dep. Com., Wash., D. C. FPL-651. 1965.)
Discusses the effects on surface quality of the angle between the plane of sanding and the plane of annual growth rings, belt speed (with and without oscillation), and feed pressure.

Popov, J. P. 1956. APPLYING THE THEORY OF CUTTING TO THE PROCESS OF SANDING WOOD. Les. Zh. 8(4): 86-91.

Powell, H. L., Stephen, B., Graham, P. H., and others. 1967. WOOD SANDING WITH COATED ABRASIVES. 95 pp. Troy, N. Y.: Behr-Manning Div., Norton Company.
A compilation of 21 articles that have appeared in recent years in the trade press. Practical information is stressed. All types of sanding operations are discussed.

Schmutzler, W. 1966. SANDING MACHINES FOR PARTICLE BOARDS. Holz als Roh- und Werkstoff 24(9): 390-395.
A review of the latest equipment for surface smoothing (including various designs of belt and drum sanders, and also special rotary cutters), and the layout of board-finishing production lines.

Seto, K., and Nozaki, K. 1966. ON THE MACHINING OF PLYWOOD SURFACE WITH COATED ABRASIVES. Hokkaido Forest Prod. Res. Inst. Rep. 49, 27 pp. Japan.
Closed-coat aluminum oxides in grit sizes of JIS AA No. 100, 150, and 180 on paper backing were tested on a triple-drum sander and on a wide belt sander. Seven hardwoods were tested: birch (Betula *sp.), beech* (Fagus *sp.), oak* (Quercus *sp.), lauan* (Shorea *sp.), shina* (Tilia *sp.), sen* (Kalopanax *sp.), and Tamo* (Fraxinus *sp.). Depth of cut had a positive linear relationship to sanding pressure. Though a smoother surface was obtained by a "down cut," adherence of sanding dust to the finished surface and vibration of sanding belt made an "up cut" preferable. Wood removed increased linearly with belt speed, but the gain was less than the ratio of increase in belt speed. For a given belt speed, amount of wood removed was inversely proportional to the feed speed of the workpiece; maximum benefit from lessened feed speed occurred with a decrease from 30 to 20 m. per minute; power demand of the machine was constant at all feed speeds. Raised grain following wetting was most severe if panels were sanded with either very sharp or very dull abrasives. Specific cutting power increased with specific gravity of the workpiece.*

Sternal, L. S. 1967. ABRASIVE PLANING—ITS ADVANTAGES AND LIMITATIONS. Wood and Wood Prod. 72(9): 27-28.
Abrasive planing is not practical on green lumber and has very limited application on rough dry lumber. It is recommended for surfacing (1) glued-up lumber (to avoid torn grain); (2) banded material (to avoid torn grain, breakoff, dubbing of cross-grain banding, the effect caused by the knife planer in compressing banding of different density than the panel); and (3) panels that require a cut smaller than 3/64 inch (to avoid knife burning and surface defects said to result from too shallow a cut with a knife planer). When planing glued-up red maple panels at 60 f.p.m. with a 36-grit belt removing up to ⅛ inch from each side, belt life is 45 to 50 hours, and belt cost is 10 cents per 1,000 surface feet of single side. For removing up to ¼ inch from banded particleboard, belt cost is 60 cents per M surface feet of single side, and the total cost, including

labor, maintenance, and downtime, is $3.81 per M. If finish sanding is attempted with an abrasive planer, the serrated steel contact drum will cause belt splice marks to show, and a 3/0 belt will cause burning at belt speeds commonly used. These difficulties can be minimized by reducing belt speed and adding a padded platen after the contact drum. Abrasive planing takes more power than knife planing but oscillation of the abrasive belt eliminates the glueline wear seen on planer knives.

Stevens, S. F. 1966. CARE OF BELTS AND ROLLS—KEYS TO GOOD PANEL SANDING. Ind. Woodworking 18(11): 24-25, 47.
Describes sanding belts commonly used on through-feed sanders in modern plywood and particleboard plants. Causes of belt failure and wear are discussed. Recommendations are given for prolonging the life of belts and contact rolls.

VENEER CUTTING

Anonymous. 1965. NEW DEVELOPMENT IN THE MANUFACTURE OF ROTARY-CUT VENEER. Holz als Roh- und Werkstoff 23(10): 420-421.
Describes the equipment of the Bettoni system (patent pending) for continuous processing of peeled veneer. The system includes automatic feeding from high-speed peelers, storage, and automatic transfer to the subsequent machines. The process permits pretreatment of the veneer by squeezing, steaming, or predrying.

Anonymous. 1967. COAST FIRM PROCESSES BLOCKS INTO BASKETS. Ind. Woodworking 19(1): 30-31.
Briefly describes a method used by Pacific States Box and Basket Company of making baskets from blocks of Sitka spruce. Machines, designed and built by the company, slice wet blocks into sheets 0.025 to 0.033 inch in thickness. Slices are then folded into box shape and a steel rim crimped to the top.

Anonymous. 1967. (Machinability of Lumber and Particleboard)

Ainslie, W. C. 1965. SURFACE CHARACTERISTICS OF DOUGLAS-FIR AND HEMLOCK VENEER. M. F. Thesis. Univ. Wash., Seattle.
The wood structure of commercially cut Douglas-fir veneer was characterized. The samples ranged from rough to smooth, and tight to loose. A technique was developed to record the original roughness of the sample areas by stereoscopic photography. After the samples were cut from the larger sheets, they were embedded and surfaced in the transverse direction with the microtome knife. These transverse surfaces were studied with the microscope to determine how the wood structure had been ruptured or changed by the veneer cutting operation. In internal failures such as lathe checks and compression tearing, the summerwood ruptured by separation between cells in the vicinity of the compound middle lamella (intrawall failure). Springwood cells ruptured across the cell wall through the cell (transwall failure). At the veneer surface produced by the knife edge, approximately two-thirds of the summerwood cells ruptured by intrawall failure. The other third ruptured by various forms of transwall failure. In springwood cells nearly all failure was transwall. Various forms of lathe checks or other internal ruptures are illustrated and discussed. It was evident that there were different degrees of compression tearing and that lathe check form was influenced by the wood structure.

Bartos. 1964. (Patents)

Collins. 1965. (Patents)

Cropp, J. 1966. MODERN VENEER SLICERS. Holz als Roh- und Werkstoff 24(4): 145-157.
Discusses the development, application, and equipment of modern veneer slicers. Describes preparation of wood and adjustment of slicers. Light and heavy horizontal as well as vertical slicers were considered the most important designs.

Feihl and Godin. 1965. (Machinability of Lumber and Particleboard)

Feihl, O., and Godin, V. 1967. IMPROVED PROFILES FOR VENEER KNIVES. Can. Dep. Forest. Dep. Pub. 1158, 13 pp.
The resistance of veneer knives to damage by knots and hard particles embedded in the logs can be improved considerably (without loss of veneer quality) if the bevel angle is increased to about 30° on a very narrow strip along the knife edge. Techniques for preparing this special edge "microbevel" are described. In addition, the study showed that decreasing the main bevel of the knife to half its value —10° instead of 20°—resulted in tighter veneer; however, the 10° bevel did not increase veneer smoothness.

Feihl, O., and Godin, V. 1967. WEAR, PLAY, AND HEAT DISTORTION IN VENEER LATHES. Southern Lumberman 215 (2671): 14-22. (Also published in 1967 as Can. Dep. Forest. Dep. Pub. 1188, 12 pp.)
Describes causes and correction of wear, play, and heat distortion in lathes. Topics include (1) horizontal play in connections between the bar and knife assemblies, (2) wear of the pressure-bar ways, (3) wear of the block under the pressure-bar adjusting screw, and (4) distortion by heat of the knife and bar assemblies. The technique of mounting dial gauges on the lathe carriage for detecting horizontal play is explained.

Hayashi, D. 1962. STUDIES ON VENEER CUTTING. Univ. Educ. (Fac. Agr.) Mem. 8, pp. 180-216. Tokyo.
Discusses the relationship of cutting resistance and its direction to clearance angle, moisture content, and depth of cut in orthogonal cutting of veneer. Considers the effects of nosebar opening, clearance angle, and cutting velocity on thickness and lathe checks of flat-grained veneer cut on a slicer. Effects of the nosebar on rotary-cut veneer are discussed.

Jain, N., Gupta, R., Shah, R., and Tandon, R. 1966. STUDIES ON PEELING CHARACTERISTICS OF INDIAN TIMBERS. Holzforschung und Holzverwertung 18(6): 108-109.
Veneer 0.8 mm. thick was cut from Indian timber of eight species, and an attempt was made to correlate cutting resistance with properties of the veneer, e. g., specific gravity and veneer quality. Settings of the lathe were constant; knife angle was 91.2° (90° plus clearance angle), vertical gap between pressure bar and knife (vertical nosebar opening) was 0.38 mm., horizontal gap between pressure bar and knife (horizontal nosebar opening) was 0.68 mm., height of the knife from the plane of the center of chucks was zero, and speed was 100 ± 5 f.p.m. Cutting resistance varied with specific gravity and increased rapidly at densities greater than 0.6, probably because of unfavorable machine settings. Cutting resistance increased linearly with

tensile strength across the grain for both solid wood and veneers; tensile strength of solid wood was greater than that of veneers. Quality of the veneers increasd as cutting resistance decreased.

Kanashkin, I., and Onishchenko, Z. 1961. LINING MATERIAL ON THE BASIS OF MICROVENEER. Derev. Prom. 10(8): 11-12. (Translated by Israel Program for Sci. Transl., Jerusalem IPST Cat. No. 1572. 1966.)
Good quality veneer 0.08 to 0.1 mm. thick, 0.8 to 1 m. wide, and 300 m. long was obtained from birch and other hardwoods using a modified FR-37 Raute peeling machine. Tool cutting angle (sharpness angle) was 20 to 22°, backing off angle was + 0.5 and 2°, backing ruler angle was 50 to 55°, and tool height (above spindle line) was + 0.5 and −1.5 mm. Lowest values for mean roughness of the birch microveneer were obtained with a tool cutting angle of 22°. Strength along the fiber of the microveneer was 360 to 565 kg. per square centimeter. To line (overlay) plastics, the microveneer was not impregnated because blue penetrated the pores of the wood and was polymerized on its surface during heating of the stack. Under production conditions, veneer plastics were obtained as sheets up to 3 mm. thick, 800 to 1,000 mm. wide, and 1,000 mm. long by hot-pressing stacks assembled from the microveneer and paper sheets impregnated with resins. Veneer plastics lined on one or both sides compared favorably with laminated plastics. Texture of the microveneer reproduced that of the wood. Color depended upon the hue of the base used.

Krisztian, G. 1966. THE MANUFACTURE AND USE OF THIN FACE VENEERS. Holztechnologie 7(3): 172-176.
In an effort to increase yield, it was found that face veneers of walnut and mahogany could be cut as thin as 0.3 to 0.4 mm. With suitable substrate preparation face veneers of this thickness can be used by the furniture industry.

Leney, L., and Moir, R. H. 1967. VENEER CHARACTERISTICS AS RELATED TO FAILURE IN PLYWOOD TENSION-SHEAR SPECIMENS. Forest Prod. J. 18(4): 33-39.
Small areas of Douglas-fir and hemlock veneer were chosen for a range of variability and characterized by study with the microscope. Cutting ruptures such as lathe checks and compression tearing were marked with dye. After the veneer had been assembled into a plywood panel, tension-shear specimens were cut in such a way that the exact area which was studied and marked became the test area in the center of the tension-shear specimen. The cross section of the core veneer was prepared so that the development of failure during stressing could be recorded photographically. By comparing the failed sample with the photographs of failure development it was possible to see how veneer characteristics are involved in the failure of dry plywood when the checks are in the pulled-closed condition.

Lutz, J. F. 1967. A SURVEY OF SOME DEVELOPMENTS IN SLICING AND VENEER CUTTING. *In* IUFRO Congr. Proc. 1967, Vol. 9, Sect. 41, pp. 25-38. Munich.
A survey of the history, current industrial usage, and research status of (1) the roller pressure bar, (2) the inclined cutting principle, and (3) veneer cut thicker than ¼-inch. Research results are specified in detail.

Lutz, J. F. 1967. RESEARCH AT FOREST PRODUCTS LABORATORY REVEALS THAT HEATING SOUTHERN PINE BOLTS IMPROVES VENEER QUALITY. Plywood and Panel Mag. 7(9): 20-28.
Knife deflection and roller-bar loads were increased proportionally to the temperature of southern pine disks heated prior to peeling. In clear wood, veneer thickness and roughness were not significantly affected by temperature. However, sound pitchy knots that cut well at 140° F. turned the knife edge at 35° F. Veneer cut at 140° F. or higher had greater strength in tension perpendicular to the grain than wood cut at 77° F. or lower. Usable veneer could not be cut from disks at 0° F. The author recommends that pine bolts be heated to 140 to 160° F. before cutting. Heating should lessen wear of knife and roller bar and improve veneer quality, primarily by reducing handling splits.

Lutz, J. F., Duncan, C. G., and Scheffer, T. C. 1966. SOME EFFECTS OF BACTERIAL ACTION ON ROTARY-CUT SOUTHERN PINE VENEER. Forest Prod. J. 16(8): 23-28.
Small, clear disks of southern pine were stored for 6 months in warm water (72 to 88° F.) to promote the development of bacteria. They were then rotary-cut into veneer about 1/12-inch thick, as were matched disks that had been stored at 35° F. Microscopic examination showed the sapwood in disks stored in warm water had been attacked by bacteria that removed the parenchyma in the rays and resin ducts. Wood from the disks stored in warm water was generally more permeable and absorptive to water in the longitudinal and radial directions than wood from the disks stored at 35° F. There was no evidence that flexibility, toughness, or specific gravity had been reduced by the bacterial infection. The disks stored at 35° F. lost less water in cutting than the disks stored in warm water, a further indication that the latter had higher permeability. Loads developed on the roller bar were significantly higher for the disks stored at 35° F. These higher loads were reflected in thinner veneer that was weaker in tension perpendicular to the grain than the veneer cut from disks stored in warm water. Roughness was generally similar for veneer cut from disks stored in warm water and from disks stored at 35° F.

Lutz, Mergen, and Panzer. 1967. (Orthogonal Cutting)

Lutz, J. F., and Patzer, R. A. 1966. EFFECTS OF HORIZONTAL ROLLER-BAR OPENINGS ON QUALITY OF ROTARY-CUT SOUTHERN PINE AND YELLOW-POPLAR VENEER. Forest Prod. J. 16(10): 15-25.
The effects of various horizontal roller-bar openings were evaluated by rotary-cutting veneer from clear wood of southern pine and yellow-poplar. The optimum roller-bar openings for yellow-poplar were found to be smaller than those for southern pine. High-speed movies showed that, for a given lathe setting, splitting ahead of the knife was more common in southern pine than in yellow-poplar. This splitting caused the southern pine veneer to be rougher and weaker in tension perpendicular to the grain than the yellow-poplar veneer. In contrast to the theory that knife deflection should be at a minimum for good cutting, the study showed that the knife deflected slightly into the disk when the best quality veneer was produced. For a given species and veneer thickness, veneer quality was related to the load on the roller bar. The work indicates that continuous measurement of knife deflections and loads on the roller bar might serve to monitor and control the veneer-cutting process.

Meriluoto, J. 1966. RAW MATERIAL FACTORS IN THE ROTARY CUTTING OF BIRCH VENEER. Paperi ja Puu 48(3): 73-80.

Meriluoto, J. 1967. HEATING AND COOLING OF BIRCH BOLTS. Paperi ja Puu 49(4): 305-307.
The elevated wood temperature required for rotary cutting is generally achieved by soaking the bolts in warm water. Time needed for heating birch bolts, which were of different diameters and 65 cm. long, was tested in three different water temperatures. The initial temperature was that of ordinary summer conditions. The cooling rate of the bolts, which had been soaked in + 40° water, was studied at an air temperature about + 18° C. Nearly a

half of the benefit gained by soaking the bolts at temperatures up to + 35° C. was lost in about 12 hours.

Nearn, W. T. 1965. WOOD-ADHESIVE INTERFACE RELATIONS. Offic. Dig. Federation Soc. Paint Technol. 37(485): 720-733.
When Douglas-fir is rotary-peeled, the thin-walled springwood cells fracture across the cell wall, thus accentuating the irregularities inherent in its large lumens; summerwood fractures within the cell wall and hence presents a relatively smooth, tight surface with few lumens opening to it. H. E. Garland in 1939 and L. Leney in 1960 made similar observations. Transmitted light photomicrographs of replicas show that the surface of fir veneer is composed of various portions of the cell wall so that the aspect which it presents to a coating or adhesive is not uniform. They also show that there is a fair amount of cell-wall debris that appears to be but partially attached to the surface. (Only machining aspects of article abstracted.)

Necesany. 1965. (Properties of Wood)

Siapno, A. E. 1963. THE EFFECT OF LATHE NOSEBAR COMPRESSION ON THE MOISTURE CONTENT AND QUALITY OF DRIED VENEER. Philippine J. Forest. 19(1/4): 1-14.
Veneers 1/10-inch thick were cut from bolts of tangile and red lauan heartwood at 10, 20, and 30 percent nosebar compression and then ovendried under identical conditions. Green and dry moisture content was determined for veneers cut with the three percentages of nosebar compression. Quality of the dried veneers was related to the drying-produced defects. Veneers were cut from both the outer and inner zones of the bolt for each nosebar compression. Results were similar for both species. Green moisture content of the veneer was not related to the amount of nosebar compression. Dry moisture content decreased as nosebar compression increased, but differences were not large enough to create drying difficulties. Face and through checking did not occur. End splitting was greatest in loose veneers cut at 10-percent nosebar compression and decreased when compression increased. End waviness decreased with decreasing nosebar compression. Very slight buckling was observed in tight veneers cut at 30-percent nosebar compression. Shrinkage in the tangential and radial directions for both species was less than 7 percent. These drying defects were very slight and the quality of the dried veneers was very satisfactory. Nosebar compression insignificantly affected the moisture content and quality of the veneers.

Williamson. 1965. (Patents)

CHIPPING, FLAKING, AND GRINDING

CHIPPING

Anonymous. 1966. WOODYARD OF TOMORROW: 1,000 TPD, NO WORKERS IN SIGHT. Pulp and Pap. 40(46): 45-48.
Experts predict that by 1976 fewer and larger plants will produce 1,000 tons of chips per day and be completely operated by one or two men. Barking may be ultrasonic. Chips may be transported by pipelines. Chipping will be done in the woods only when the advantages are overwhelming. Mills must be prepared to handle a full range of wood. Gravity-flow flumes will disappear as mills switch to outside chip storage; logs may be transported from the log handling discharge to chippers via water flume. Only enough logs will be stored to maintain a supply of a few hours or days in case of transportation failure. Chips for sulfite pulps may be stored for 5 to 7 weeks. The article contains some recommendations for chip handling in northern climates. In Cedar Springs, Georgia, outside chip storage proved to be a satisfactory and economical method. A woodyard there chipped an average of 1,440 cords per day at a total operating and maintenance cost of $1.20 per ton of pulp.

Calvert, W. W., and Johnston, J. S. 1967. TESTS SHOW LUMBER, CHIP RECOVERY HIGHER ON BAND THAN ON CIRCULAR SAWS. Northern Logger 16(5): 23-27.
White spruce logs 12 and 16 feet long and 6 to 15 inches in diameter were debarked and then sawn on a laboratory headrig that could accommodate either a bandsaw with ⅛-inch kerf or a circular saw with 9/32-inch kerf. For the average log (approximately 10 inches in diameter in both length groups), the bandsaw recovered more lumber than the circular saw. The advantage was 5½ and 9 percentage points for 12- and 16-foot logs, i. e., for 16-foot logs the circular saw recovered in lumber 60.2 percent of the volume of a 10-inch log, whereas the bandsaw recovered 69.3 percent. In addition, the bandsaw permitted recovery of 3 to 5 percent (in terms of total volume of the log) more chippable residues than the circular saw. When 10-inch, 16-foot logs were bandsawn, 20.3 percent of the total volume was recovered as chippable residue, whereas only 17.3 percent was recovered with the circular saw. On the same 10-inch logs, the bandsaw converted 10.4 percent of the total volume to sawdust whereas the circular saw converted 22.5 percent of the log volume to sawdust. A chart shows yield results over the full range of diameters for 16-foot logs.

Crowley, E. L., Zaichkowsky, A., Wardwell, N. P., and Rogers, J. R. 1966. DISK CHIPPING LONG OR SHORT LOGS. Pap. Trade J. 150(46): 67-70.

Crowley, E. L., Zaichowsky, A., Wardwell, N. P., and Rogers, J. R. 1966. LARGE CHIPPERS CUT COSTS, UP PRODUCTION. Pulp and Pap. 40(45): 37.
The trend in the last few years has been towards larger chippers for larger logs, thus increasing production and saving manpower. Blowing vanes on a chipper utilize the initial momentum of the chips to accomplish efficient chip transport. Furthermore, the vanes break up the chip-cards, thus eliminating the need for card-breakers. A horizontal feed spout permits knives to pass through logs at the same angle as in a gravity-fed machine. Horsepower requirements for chippers vary with specific jobs. For high production, a synchronous motor is favored; for low-production requirements and for occasional large logs, a wound rotor seems best.

Grigorov, P. 1967. CUTTING RELATIONSHIPS IN DISK CHIPPERS HAVING HELICOIDAL KNIVES AND CUTTERS. Nauch. Tr. Lesoteh. Inst. 14, pp. 147-158.
A detailed theoretical analysis of cutting, from which three nomograms were constructed for calculating the basic parameters of the cutting schedule.

Hartler, N. 1966. THE CCL CHIPPER. Pulp and Pap. 40(1): 17-20.
Describes a chipper in which the knife-edge moves perpendicular to the grain (to cut in the veneer direction) rather than parallel to the grain as in the conventional chipper. Lower specific cutting energy and less chip damage are claimed.

Herrick, O. W., and Christensen, W. W. 1967. A COST ANALYSIS OF CHIP MANUFACTURE AT HARDWOOD SAWMILLS. U. S. Dep. Agr. Forest Serv. Res. Pap. NE-69, 14 pp. Northeast. Forest Exp. Sta., Upper Darby, Penn.
A study of the cost of converting hardwood residues to pulp chips at seven selected sawmills in the western Appalachian region. Emphasis is on identifying all factors that determine the change in total net cost to the sawmill.

Koivelehto, P. 1966. CRUSHED STUMPS AS RAW MATERIAL FOR THE PULP INDUSTRY. Metsat. Aikak. 83(3): 163-165.
One of the chief obstacles in using stumps for pulpwood has been inability to find a machine not damaged by stones and sand. A Swedish machine, the m/Jansson, has given promising preliminary results. The coarsest chip fractions must be screened again for rechipping. The fine fraction is burned.

Larsen, L. E. 1966. SULFITE PROPERTIES ENHANCED THROUGH USE OF NEW CHIPPER. Pulp and Pap. 40(15): 58, 63. *Also as* CURRENT WORK ON THE NEW SODERHAMN CHIPPERS. TAPPI 50(2): 61A-64A. 1967.
Pulps from chips made by Soderhamn drum and H-P spiral chippers were compared to pulps from chips cut by conventional disk machines. Sulfite pulps from hemlock drum chips (2½ inches long, 0.130-inch thick, and varying in width), had 10 percent higher burst strength, 7 percent higher tear strength, and 13.5 percent greater breaking length than pulps from conventional disk chips. Drum chips of alder produced a sulfite pulp with 28.5 percent higher burst strength, 55.5 percent higher tear strength, and 15 percent greater breaking length than pulp from conventional chips. A kraft pulp from cedar-hemlock drum chips had negligible increase in strength. Sulfite pulp from hemlock chips (1¼ inches long, ¼-inch thick, and varying in width) from the H-P spiral chipper had 17 percent higher burst strength, 13 percent greater breaking length, and lower tear strength than pulp from conventional chips. Kraft pulp from hemlock chips from the H-P chipper had 11 percent higher tear strength, 7 percent greater breaking length, and a marginal increase in burst strength. Kraft pulp from alder chips from the H-P chipper had approximately the same strength as the pulp of conventional chips. Unbleached yield for sulfite and kraft pulps was 1 to 1½ percent lower for H-P than for conventional chips. The drum chipper yielded a lower percentage of screenings than the conventional disk chipper, while the H-P chipper had a higher percentage. No advantage in brightness was noted for pulps from chips made by the drum and H-P chippers.

Lichman, E. P. 1967. INVESTIGATION OF DRUM CHIPPERS. Les. Zh. 10(3): 53-63.

Nolan, W. J. 1967. CHIP SHREDDING—WHY NOT INVESTIGATE FURTHER? Pulp and Pap. 41(44): 57-58.
Slash pine chips made on 12- and 15-knife Norman chippers, and with moisture contents of 40-45 percent were passed through a 28-inch Vertiflex attrition mill. The plates had teeth ¾-inch high in the inner zone and ⅜-inch high at the periphery. Plate clearance for shredding was 0.900 inch, corresponding to a clearance of 0.525 inch between the tips of the teeth on rotor and stator. Rotor speed was 1,800 r.p.m. Feed rate to the mill was 1.2 tons (air-dry) of chips per hour, which was less than 10 percent of the capacity of the 100 hp. unit. Kraft pulps from shredded chips are as strong in breaking length, burst, and tear as those from unshredded chips. Yield of slash pine pulp was greater from shredded than from mill-size chips. Since all knots are shredded along with the straight-grained chips, knots will cook as thoroughly as normal wood; knotters thus may be eliminated. Fines should be left with the shredded chips, as they will cook to at least 45-percent yield.

Pahlitzsch, G., and Mehrdorf, J. 1963. MANUFACTURE OF CHIPS BY FLAT DISC CHIPPERS. Holztechnologie 4(3): 209-222.
Experiments with pine, copper beech, and poplar wood show that it is possible to manufacture chips within the thickness range from 0.1 mm. to 0.8 mm. on a specially equipped horizontal flat-disk chipper. These chips satisfy requirements for a certain quality of particleboard. Cutting force, formation of splits, and surface roughness are inversely proportional to wood moisture content. With the increasing cutting rate, splitting decreases. A change of the chip angle from 45 to 40° causes enlargement of the sharpness angle which in its turn prolongs the knife life. Cut-surface angles from +3 to +6° are advantageous. The cutting-edge angle ought to be between 10 and 30°. The inclination angle has influence only if the knife-edge angle is simultaneously changing.

Pahlitzsch, G., and Sommer, I. 1966. PRODUCTION OF WOOD CHIPS WITH A CYLINDER-TYPE CHIPPING-MACHINE. PART II—EFFECT OF KNIFE GEOMETRY ON BLUNTING, CUTTING AND FEED FORCE, AND ON THE QUALITY OF CHIPS. Holz als Roh- und Werkstoff 24(3): 109-117.
Knives with a clearance angle of 6°, lip angle of 49° (sharpness angle) and hook (rake angle) of 35° gave optimum chipping conditions. Chips produced by a cylinder-type chipping machine were not inferior to chips produced by a horizontal flat-disk chipper.

Pahlitzsch, G., and Sommer, I. 1966. PRODUCTION OF WOOD CHIPS WITH A CYLINDER-TYPE CHIPPING-MACHINE. PART III—INFLUENCE OF ANGLE OF INCLINATION, OF BLADE AND OF DIRECTION OF CUT. Holz als Roh- und Werkstoff 24(4): 158-166. (Translated by Joint Pub. Res. Serv., U. S. Dep. Com., Wash., D. C. FPL-671. 1966.)
A specially designed cylinder-type chip cutter with pitched knife racks and constant effective angles was used for tests performed on pine. An inclination angle of 20° was favorable for uniformity of chip thickness and smoothness of chip surface. Instead of inclining the knife by 20°, tilting the workpiece against the axis-parallel knife to form an angle of 20° gave favorable values of chip thickness and chip surface smoothness. Chip size and chip fissures under this condition were acceptable. Inclining the knife as well as the workpiece to an inclination angle of 20° together with a knife-edge angle (sharpness angle) of 25° was not advantageous since it increased cutting forces, variation in chip thickness, chip roughness, chip curvature, and amount of fines. It also decreased the interval of chip fissures. With a blunted cutter, it was advantageous to feed the workpiece against the axis-parallel knife at an inclination. Inclining knives at an angle of −10° and feeding the workpiece at an angle of +25° gave favorable chipping conditions. Using inclination angles not equal to 0° avoided heavy impact stresses caused by the entry of the knife into wood.

Pahlitzsch, G., and Sommer, I. 1966. PRODUCTION OF WOOD CHIPS WITH A CYLINDER-TYPE CHIPPING-MACHINE. PART IV—INFLUENCE OF CHIP-SPACE CONFIGURATION ON CHIP FORMATION AND FLOW. Holz als Roh- und Werkstoff 24(6): 260-269. (Translated by Joint Pub. Res. Serv., U. S. Dep. Com., Wash., D. C. 1966.)
Cylinder cutters were discussed in detail. From the kinematics of the cutting action, a disk chipper has shorter cutter life, produces chips less uniform in thickness, and creates more fines at large chip widths than does a cylinder chipper operating under optimum conditions. Specific cut-

ting energy appeared equal for disk and cylinder-type chippers.

Papworth, R. L., and Erickson, J. R. 1966. POWER REQUIREMENTS FOR PRODUCING WOOD CHIPS. Forest Prod. J. 16(10): 31-36. *Also in* Pulp and Pap. 41(23): 40-41.
Variables investigated were spout feed angle, knife sharpness angle, chip length, density, and knife sharpness. Five northern species were tested: hard maple, soft maple, aspen, eastern hemlock, and spruce. Tests were performed with a 39-inch, three-knife, disk chipper cutting 4-inch by 4-inch by 8-foot samples. Power consumption was measured by a strain-gauge dynamometer and recorded on an oscillograph. Spout feed angle has little effect on chipping power. Knife sharpness angle noticeably affected power consumption, with blunt knives requiring more power. Long chips require less power per unit volume than do short chips. Graphs and tables show the relative effects of the variables tested.

Schmied, J. 1964. THE EFFECT OF THE SIZE, SIZE NONUNIFORMITY, AND THE SHAPE OF CHIPS ON THE COOKING UNIFORMITY IN PULPING. Papir a Celulosa 19(4): 100-106.
Theoretical and experimental study of the effects of chip size and shape on the uniformity of wood delignification led to several conclusions: Size of the chips affects the cooks when the cooking is rapid and if the chips have a high moisture content. Because of a relatively long diffusion path in large chips, the pulping chemicals do not penetrate to the center of the chips on time, i. e., before delignification proper begins; the result is undercooked chips. Hence, if large chips are used, the time of digester heating must be prolonged. The relations between the chip size and heating time is such that a twofold increase of chip size requires a fourfold prolongation of the impregnation time. Heterogeneity in size has a detrimental effect: small chips absorb a large fraction of the pulping chemicals, and at the end of the diffusion process the concentration of chimicals in the small chips exceeds the equilibrium concentration. Side reactions may then deplete chemicals in the liquor and in undercooked large chips. For this reason, mixtures of chips with sawdust should be avoided. At the beginning of impregnation, the diffusion front of the chemicals follows the edges of the chips, but in later stages the front assumes a rounded form and the undercooked chips, depending on their initial shape, are either cylindrical or ellipsoidal. The effects of chip size and their heterogeneity is considerably reduced when the chips are dry, as in this case the pores of wood can be filled more easily, especially if impregnation methods are adequate.

Scott, J. B. 1966. PROCESSING OF CHIPS AND WOOD WASTES FOR MECHANICAL AND CHEMICAL PULPS. Norsk Skogindustri 20(9): 320-328.
Describes chip shredding (the process of splitting chips along the natural lines of cleavage without breaking across the grain, crushing, or otherwise mechanically damaging the fibers) and the equipment used. Discusses the mixtures of sawmill waste that can be used in pulping and the production of "chip groundwood" or "refinermechanical" pulp.

Sommer, I. 1966. PRODUCTION OF WOOD CHIPS WITH A CYLINDER-TYPE CHIPPER. Holz-Zentralbl. 92(110): 1968-1969.
Discusses the effects of cutting speed, chip thickness, and chip space on energy consumption. A chip space with rounded corners and an angle of 45° between front wall and cutting direction reduced splinter percentage by up to 80 percent and energy consumption by up to 20 percent in comparison with spaces having sharp corners and a near-vertical front wall.

Szostak, M. 1967. TECHNOLOGY OF MECHANICAL CHIPPING OF SMALL WOOD. Prace Inst. Bad. Les'n. 323, pp. 57-88.

Vethe, A. 1967. USE OF SHREDDED CHIPS IN CHEMICAL PULPING. Norsk Skogindustri 21(5): 180-187.
Chemical pulping involves complex topochemical reactions. Hence, chip dimensions have appreciable effects on speed and completeness of these reactions. In general, both the yield and quality of pulps are higher when chips of fairly small and uniform size are cooked. Laboratory and industrial pulping trials indicated that shredded chips are a good alternative to the use of new types of chippers and/or more severe impregnating conditions to obtain maximum yields. Shredding of chips does not seem to affect the strength properties of sulfate and bisulfite pulps, but may reduce the tear strength of acid sulfite pulps. Results from industrial pulping comparisons of shredded vs. regular chips will vary from mill to mill, depending on chip quality and on impregnating and cooking conditions used.

Wahlman, M. 1967. IMPORTANCE OF CHIP THICKNESS IN ALKALINE PULPING, AND CHIP THICKNESS ANALYSIS. Paperi ja Puu 49(3): 107-110.
Chip thickness affects the chemical defibration process. In laboratory studies, a chip thickness of 2 and 5 mm. imparted maximum strength properties to the pulp. Screenings began to be excessive when chip thickness exceeded 5 mm. In industrial production, the upper limit can range to approximate 7 mm. Random sampling of chip thickness at the Joutseno-Pulp Oy. kraft mill was facilitated by development of a classifer screen operated by a Williams mechanism.

Zavojskih, G. I. 1967. CUTTING FORCE IN A DISK-TYPE CHIPPER. Derev. Prom. 16(4): 12-14.

CHIPPING HEADRIGS AND EDGERS

Anonymous. 1966. "CHIP-N-SAW" FEATURED IN NEW VIRGINIA OPERATION. Southern Lumberman 212(2640): 31-32.
The Chip-N-Saw is used in a new 16-man, half-million dollar sawmill to produce lumber from timber normally considered pulpwood, i. e., as small as 5 inches in diameter. Spain Lumber, Inc., at Wakefield, Virginia, expects an initial daily output of 40 to 50 M b.f., with 60 to 75 M predicted by the end of 1966. One man at a console operates the 24-ton machine, producing lumber and chips in one operation. It has a capacity of five 16-foot logs a minute, yielding up to 6,240 board feet per hour in sizes ranging from 1 by 4 to 2 by 10. Southern pine is the major species utilized, but results in hardwood have also been excellent.

Anonymous. 1966. CHIP-N-SAW PRODUCES LUMBER AND PULP CHIPS. Southern Lumberman 212(2635): 26.
A 12-inch Chip-N-Saw (Model 1241-60), manufactured by Canadian Car (Pacific), Ltd., Vancouver, British Columbia, is designed to process logs up to 14 inches in diameter at an operating speed of 60 f.p.m. It produces accurately sawn lumber and uniform, rotary-cut pulp chips in a single operation. This model will recover an average of 61 percent of the log volume in lumber, 32 percent in merchantable pulp or particleboard chips, and 7 percent in sawdust.

Anonymous. 1966. NEW ECONOMY BEAVER CHIPPER-CANTER. Can. Forest Ind. 93(12): 137.
Three sizes of Beaver chipper-canter manufactured and engineered by Stetson-Ross, Seattle, Washington, are available: the economy model handles small logs and cores up to 11 inches in butt diameter, the No. 2 Beaver takes up to 14 inch logs, and the No. 4 up to 24-inch butt diameter.

Logs up to 24 feet long are processed at 183 to 250 f.p.m. Products are uniform chips with fiber length of 5/8 to 7/8 inch and marketable cants, timbers, or ties. An integral double-arbor splitting unit is available to produce dimension lumber in one pass. Earlier models of the Beavers are reported to produce 100,000 board feet per shift with crews of three to four men. Newer models have been improved for greater production and improved chip quality.

Anonymous. 1966. SAWMILL INCREASES LUMBER, CHIP OUTPUT. Forest Ind. 93(12): 118-119.
An increase of 35 percent (to 110,000 board feet per shift) in lumber production by Balco Forest Products, Ltd., at Heffley Creek, British Columbia, was realized with installation in March 1966 of a whole-log processing machine in an existing sawmill. The Model 1242 Chip-N-Saw, operated by one man, produces pulp chips and dimension lumber from logs with top diameters of 4½ to 14 inches. Most material is 7- to 11-inch lodgepole pine. Production per shift averages 1,400 logs, but 2,000 have been handled. With 30 pieces per M b.f. lumber scale, 45 to 50 M b.f. are produced per shift. Chip recovery is 1.2 units per M b.f. Lumber size may be adjusted from 2 by 3 through 2 by 12. Slab material is chipped away to profile a stepped cant ahead of double-arbor saws. Most logs are bucked to 16 feet. Short and long logs have separate infeed chains. Debarking is by a Nicholson 36-inch ring barker with a Morbark rosserhead barker for large logs. An end-haul chain carries the logs to a system of storage and feed chains serving both the Chip-N-Saw and a circular headrig with cant gang and edger. Production from both systems merges ahead of a rough trimmer. Grade recovery is not as high as from selective sawing, but this loss is more than offset by savings in production costs.

Anonymous. 1966. SMALL LOGS RECEIVE PRIMARY BREAKDOWN IN CHIP-CANT MILL. Forest Ind. 93(3): 104-105.
E. Manke & Sons on Hylebos Waterway, Tacoma, Washington, utilizes logs 5 to 24 inches in diameter and up to 24 feet long to produce cants and chips. After being bucked with a circular deck saw, the logs pass through a Nicholson barker and Stetson-Ross No. 4 Beaver chipper-canter. The infeed table adjusts automatically for sweep and flare. Cants are produced at a rate of 183 lineal f.p.m.; chips have a uniform length of 5/8 inch. From the roll case, random-length cants move via transfer chains to be steel-strapped into 3,000-board-foot bundles for shipment.

Anonymous. 1966. STUD MILL INSTALLATION EXPANDS TIMBER SUPPLY. Forest Ind. 93(4): 94-95.
The Del Connor Lumber Company at Darby, Montana, has installed a small-log stud mill (in addition to its 50 M per shift, 7-foot band headrig) to utilize nearby stands of suppressed timber (Douglas-fir, lodgepole pine, spruce, and white fir). A Selectric Beaver No. 2 chipper-canter was installed along with a Selectric dimension machine to convert cants into 2 by 4's. The dimension machine carries carbide saws that take a 5/32-inch kerf. Production on the Beaver averaged 25 M b.f. per shift initially (maximum 33 M b.f.); addition of a separate infeed for peeler cores raised this to 45 to 50 M b.f. per shift. The average log fed to the Beaver is 6½ inches in diameter and contains 30 board feet. After modifications, maximum log size will be 12 inches, with cants up to 8 inches possible. Two studs are recovered from each 5¼-inch core. Production runs 60 percent cores and 40 percent logs. Lumber is air-dried and surfaced in a planing mill. Logs 8 to 20 feet in length are fed by a LeTourneau stacker to a stationary deck, where a Prentice Hydraulics, Inc., grapple loader is mounted. Here logs are sorted and placed on the end-haul chain to a Morbark 24-inch barker. Three operators (one each for loader, barker, and chipper-canter) and two greenchain pullers (four when handling cores) are required. The stud-mill (sawing lodgepole pine) yields 1.2 units of chips per M b.f. (cores yield only about 0.4 unit) compared to between 0.6 to 0.7 unit from the bandmill (utilizing Douglas-fir). Chip yield from both band and studmills totals 80 units per day. The installation includes a Rotex 122 screen with capacity of 21 units per hour, a CM&E Norman Model 48 chipper for overs and sawmill waste, and a 14-unit-per-hour Rotex 82 screen.

Anonymous. 1966. THE DIMO HOGGER. Timber Trades J. 259(4704): 70.
The Dimo Hogger, developed by Short Bros. and Harland, Ltd., Precision Engineering Division, Belfast, Northern Ireland, squares and tapers posts of various sizes. Thinnings, precut to length and 5 inches or larger in diameter, are fed hydraulically on a horizontal carriage through electrically driven chipper heads. The Dimo Hogger produces an average of 500 cubic feet of fencing post and 10 tons of chips per 8-hour shift.

Anonymous. 1967. BEAVER CHIPPER-CANTER INCREASES SMALL-LOG VALUE. Southern Lumberman 214(2658): 32, 34.
A hemlock log 20 feet long, 8 inches in diameter at the top, and 11 inches at the butt contains 30 board feet Scribner scale. Volume of wood is 9.844 cubic feet. By means of the four-head chipper-canter it is processed in 5 seconds (183 lineal f.p.m.) to yield a green 6 by 6 timber containing 60 board feet plus 4.844 cubic feet of chips worth $1.09 (i. e., 6.06 percent of an 80-cubic foot unit worth $18).

Anonymous. 1967. CHIP-CANT MILL RECOVERS LUMBER FROM PULP FOREST. Forest Ind. 94(11): 90-91.
Describes a mill built around a pair of 18-inch Soderhamn H-P chipper-canters arranged in tandem to convert small-diameter spruce, balsam, and jackpine logs into square or rectangular cants. Most logs are 8 feet 4 inches long, some are 12 feet 6 inches long. Minimum log diameter is 7½ inches and the maximum is 18 inches. At present, cant thickness is limited to the 6-inch capacity of the edger, but plans are being made to install a linebar resaw to permit processing cants up to 12 inches thick. The chipping headrigs produce 40,000 board feet of dimension lumber (2 by 3 to 4 by 6 inches) per 8-hour shift. Chip production averages 1.6 dry tons per M b.f. of lumber; or 64 tons per shift. Addition of the resaw is expected to lower chip yield. On a two-shift basis, stated annual production is 15 million board feet of lumber and 20,000 dry tons of chips. The mill (Consolidated Peribonka, Ltd.) is a subsidiary of Consolidated Paper Corp. Ltd., and is located in central Quebec near Notre Dame du Rosaire.

Anonymous. 1967. CHIPPER-CANTER AUGMENTS SAWMILL HEADRIG OPERATION. Forest Ind. 94(12): 102-103.
In February 1967, Dierks Forests, Inc. at Mountain Pine, Arkansas, started production through their small-log processing system. The system consists of a Stetson-Ross No. 2, four-head Beaver, 60-inch twin resaws fixed 4 inches apart, a double-arbor edger for the cants, and a side chipping edger. Two console operators control the system, one at the Beaver and one at the side-chipping edger. All logs up to 10 inches in diameter, and straight logs as large as 11 inches can be processed. Sawdust volume produced by the system is 5 percent on 6½-inch logs and 7 percent on 8-inch logs. Chip production is 1.67 tons per M b.f. of lumber produced. Primarily the system produces 2 by 4's, although 1 by 3's, 1 by 4's, 1 by 6's, and 2 by 6's are also cut. Shortleaf southern pine is the species cut. Logs range from 8 to 20 feet in length and average 8½ or 9 inches in diameter.

Anonymous. 1967. RECOVERY, PRODUCTIVITY HIGH IN RELATED MILLS. Forest Ind. 94(10): 94.
Lumber production of 135 M b.f. per shift is achieved through a Stetson-Ross No. 4 Beaver chipping headrig installed at Upper Fraser, British Columbia, by Northwood Pulp, Ltd. Logs up to 24-feet long and 24 inches in butt diameter are processed. Average input is 225 logs per hour. Squared cants are produced at a lineal feed speed of 251 f.p.m. Chipper heads carry segmented knives and cut chips 7/8-inch long. Cants from the four-head Beaver proceed either to a twin linebar resaw or to a Stetson-Ross 2 by 24-inch side-chipping edger equipped with chipping heads carrying segmented knives. The chipper-edger feeds at 512 f.p.m. Output from the chipping headrig and from a companion conventional mill are planed at speeds up to 1,000 f.p.m. on a 20-knife Stetson-Ross planer and then double-end trimmed automatically according to signals punched into the control system by three graders.

Anonymous. 1967. SAWMILL IS INITIAL UNIT IN HUGE FUTURE COMPLEX. Forest Ind. 94(12): 104-105.
Alexandra Forest Industries, Ltd., McKenzie Division, Columbia Forest Products, Ltd., Peace River, British Columbia, has installed a Canadian Car Chip-N-Saw to process logs 10 inches or less in diameter. Production is about 40,000 board feet per shift.

Anonymous. 1967. THE VANCE CHIP-O-MATIC CANTER. Pulpwood Prod. 15(4): 22, 24.
The prototype Chip-O-Matic canter designed by J. L. Wall was installed at the Thompson Lumber Company of Ailey, Georgia. The machine has been further developed by the J. A. Vance Company of Winston-Salem, North Carolina, who manufactured and installed a second model at the Del-Cook Lumber Company in Adel, Georgia, in January 1967. The Chip-O-Matic carries two end-milling, six-knife cutter heads, each driven by a 100-hp. motor. Distance between cutterheads is adjusted for each log by a setworks. The machine will accept logs 4 to 28 inches in diameter. Two sets of spiked hold-down rolls in front of the cutterheads, and two sets behind, are controlled by the single operator to guide random-length logs. Minimum log length is 8 feet. Twisting of logs is reportedly minimized by 3/4-inch teeth on the feed rolls and by intermediate spur rolls. The basic machine weighs about 15,000 pounds, sells for $25,000, and occupies a floor space 11 feet 5 inches long and 10 feet 9 inches wide. It stands 6 feet 4 inches high. At a log feed rate of 100 lineal f.p.m., the canter produces half-inch chips. Feed speed may be varied. At the Del-Cook mill, long logs are first debarked and then bucked. Large logs are diverted to a conventional headrig; the Chip-O-Matic receives those that will yield cants 8-inches thick or less, as this is the maximum capacity of the double-arbor edger behind the machine. No production figures are given.

Burry, H. W. 1967. CHIPPER-CANTER HEADRIGS. Northern Logger 16(2): 14-15, 40-42.
Describes Chip-N-Saw, Beaver, Chip-O-Matic, and H-P Chipper-Canter and summarizes productivity and price. Concludes:

- *Chipper-canters are most effectively used in combination with a conventional headrig.*
- *A very productive barker is required ahead of a chipper-canter.*
- *Flared butts and crooked logs are problems.*
- *Taper sawing is not possible.*
- *Chip quality is not always satisfactory.*
- *Log sorting by size is a necessity.*
- *Purchase of small logs by weight would be efficient.*
- *To get small logs in quantity may require purchasing up to 1/2-million feet per week of woods-run logs—half large ones and half for the chipper-canter.*
- *There must be a reasonably good market for lumber of the type cut from small logs and a steady market for chips.*
- *Some lumber emerging from the units needs edging.*
- *Recovery of lumber depends upon the amount of wane left on the cants.*
- *A good return on investment can be made if the chipping headrig is properly applied.*

Dobie, J. 1967. CHIPPER HEADRIG PRODUCTIVITY CUTS SMALL LOG MILLING COSTS. Forest Ind. 94(9): 82-85. *Also as* HOW CHIPPER HEADRIGS REDUCE SMALL-LOG PROCESSING COSTS. Can. Forest Ind. 87(8): 60-65.
The Vancouver Forest Products Laboratory assessed the performance of peripheral milling chipping headrigs as typified by the Chip-N-Saw and the Beaver. The three mills studied were cutting Douglas-fir, lodgepole pine, spruce, and balsam fir in interior, northwest Canada. Processing costs varied but ran no more than half the expense required for logs of the same size in a conventional mill. In addition, savings achieved by producing chips from what is normally sawdust ran between $60,000 and $90,000 per 25 million board feet of lumber output. Tabular information and graphs show log size and recovery statistics, variations in lumber recovery with log diameter, percentage of lumber volume by width and thickness, grade of lumber recovered, lumber width distribution, processing time per cubic foot of log, and estimated processing cost as a function of log diameter. Average cubic volume recovery for the three mills was: lumber 50.8 percent, sawdust 5.3 percent, and solid residue (chips) 43.9 percent. Chip yield in Interior Units (2,400 pounds ovendry chips) per hundred cubic feet of logs was 0.48 for Douglas-fir, 0.41 for spruce, and 0.47 for lodgepole pine.

Dobie, J., Sturgeon, W. J., and Wright, D. M. 1967. AN ANALYSIS OF THE PRODUCTION CHARACTERISTICS OF CHIPPER HEADRIGS, SCRAG MILLS AND LOG-GANG MILLS. Can. Dep. Forest. and Rural Develop. Forest Prod. Lab. Inform. Rep. VP-X-21, 20 pp. Vancouver, B. C.
Production studies of six chipping headrigs, six scrag mills, and four log-gang mills have shown that production varied from 3,000 to 19,000 board feet of lumber per hour, depending on mill type and capacity. The mills were in western Canada and cut softwoods (implied but not stated). Conclusions were (1) chipping headrigs, scrag mills, and log-gang mills consistently recover between 50 and 60 percent of the cubic input as lumber, (2) chipping headrigs manufacture 5 percent sawdust, as compared to 22 percent for scrag mills and about 13 percent for log-gang mills, all on dimension production, (3) lineal throughput (no delay time) was highest in chipping headrigs at 59 f.p.m., followed by scrags at 47 f.p.m., and log gangs at 24 f.p.m., (4) lumber-recovery factors are probably highest in log-gang mills, with scrag mills and chipping headrigs lower and similar to each other for existing practices, (5) chip volumes recovered by chipping headrigs were higher than potential chip volumes obtainable from scrags and log gangs, and (6) delay times varied considerably in all mill types. The proportion of operating time lost to delay averaged 48 percent for scrags, 30 percent for chipping headrigs, and 11 percent for log gangs. Therefore it is apparent that, in some instances, production could be increased considerably, without the addition of men and equipment, merely by an analysis of the causes of delay.

Heath, V. 1967. WITH CHIPPER HEADRIG, SMALL-LOG PROCESSING CAN BE PROFITABLE. Can. Forest Ind. 87(8): 68-73.
A study explored the effect on profit when new small-log processing equipment is added to a lumber manufacturing operation (hypothetical) in the northern Interior area of British Columbia. The key piece of new equipment is a Chip-N-Saw chipper-headrig, made by Canadian Car (Pacific), Ltd., Vancouver, British Columbia. Both logging and lumber production costs of the small-log mill are considered, since stumpage concessions granted by the British Columbia Forest Service to mills processing small timber (7.1 to 11.1 inches in diameter) influence the profitability of the new facility. The study indicates that revenue will increase if the new facilities are coordinated with a careful assessment and selection of timber stands. In the Chip-N-Saw small-log mill, production costs are calculated at $7.21 per M b.f. and net profit at $4.50 per M b.f. This compares with costs of $12.35 and net profit of $7.27 per M b.f. in the existing conventional mill. Aggregate net profit of the two mills is $5.51 per M b.f., which compares well with an aggregate net profit of $1.58 per M b.f. of 25 northern Interior sawmills reported by Price Waterhouse in a recent study for the Northern Interior Lumbermen's Association.

Hobbs, L. H., and Thomason, R. E. 1967. LUMBER AND CHIP PRODUCTION, A NEW APPROACH. N. C. Agr. Ext. Serv. Misc. Pub. 22, 40 pp.
With a chipping headrig installation (Chip-N-Saw) as an example, a technique is explained whereby alternative additions to manufacturing facilities can be evaluated for return on investment. Basis of calculation was a 44-log sample of southern pine, weighing 16,580 pounds. Logs averaged 7.5 inches in diameter (inside bark) at the small end, and the sample lot scaled 1,175 board feet (International ¼-inch rule). The logs yielded 1,042 board feet of lumber and 8,320 pounds of green chips. Bark from the 44 logs was estimated to total 1,510 pounds. The authors conclude that, because of taper, short logs yield a higher percentage of total cubic volume in lumber (and proportionately less chips) than do long logs. In the example, the authors assume an investment of $313,000 and calculate that return on investment would be 70.5 percent at an annual production of 12,000,000 board feet; at an annual production of 8,000,000 board feet, return was calculated at 42 percent. The analysis assumes that rough air-dry lumber is worth $68 per M b.f. net FOB plant, that 4 tons of chips are produced per M b.f. of lumber, that green chips will return $7 per ton, and that logs can be purchased at $7.60 per ton.

Johnson. 1959. (Patents)

Koch, P. 1967. DEVELOPMENT OF THE CHIPPING HEADRIG. *In* Rocky Mountain Forest Ind. Conf. Proc. 1967: 135-155. Fort Collins, Colo.
Describes events leading to development of the chipping headrig, with emphasis on the author's research in the years 1953-1963. Illustrates and describes commercial machines. Lists locations of 38 installations of chipping headrigs and edgers. Contains abstracts of nine trade journal articles describing commercial installations of chipping headrigs.

Koch, P. 1967. TOO MANY CROOKED SMALL LOGS? CONSIDER A SHAPING-LATHE HEADRIG! Southern Lumberman 215(2680): 147-149.
A fast, new experimental headrig can convert short logs or bolts into S4S cants that are square, polygonal, or round —and can cut these shapes tapered on all sides to conform to the natural taper of the log. The headrig makes no sawdust but machines the entire volume outside the cant into flakes for flakeboard or into pulp chips. Production of five logs per minute or 73 cords per 8-hour shift is considered achievable.

Kotesovec, V., and Zizka, J. 1966. THE PRODUCTION OF LONG CHIPS WHEN RIP-SAWING SLABBED LOGS. Holz als Roh- und Werkstoff 24(8): 346-353.
Compares conventional frame sawing, and sawing with a prototype machine (of a type previously described) consisting of four sets of circular saws above and four sets below the slabbed log, each tooth of each saw producing one long chip (shaving) with each passage through the wood. The sawn-surface quality produced by the prototype was superior. Feed speeds up to 50 m. per minute could be used with wood 82 to 205 mm. thick. Actual kerf width was 3.5 mm.

Ostroumov, I. P. 1966. SMALL PULP CHIPS INSTEAD OF SAWDUST. Bumazhnaya Prom. 2(2): 9.
The Central Research Institute for Mechanical Woodworking (USSR) is studying ways of improving methods of sawing to yield chips (for sulfate pulp) instead of sawdust.

Pease. 1967. (Patents)

Richardson, T. 1968. DESCRIPTION OF TANDEM INSTALLATION OF TWO SODERHAMN 12-INCH SPIRAL CHIPPER CANTERS IN LAURITSALA, FINLAND. Presented at Amer. Pulpwood Assoc. Annu. Meeting, New York. 4 pp.
Spruce and Scotch pine logs averaging 5 to 6½ inches in top diameter and 15 to 16 feet in length are first debarked and then converted to lumber at the rate of 400 to 500 logs per hour. Logs are sorted into diameter classes (±½ inch) before they enter the mill. Each canter carries two cutterheads turning at 700 r.p.m. Feed rate is 175 lineal f.p.m. Space between cutterheads is adjustable from 0 to 18 inches. Logs up to 12 inches in diameter may be completely chipped by closing the space between the disks. Logs are slabbed on two sides by the first canter, automatically turned down, and squared on the second canter. Resulting cants are resawn to yield 2 by 4's, 2 by 6's, or 3 by 6's. On a two-shift basis, annual production of the mill is 32 million board feet. One man operates debarker, conveyors, and both canters. Chips are utilized in a Kamyr continuous digester.

MOBILE CHIPPERS

Anonymous. 1966. "CARGATOR" PORTABLE BARKER-CHIPPER UNIT. FAO Forest Equip. Notes D. 42.66, 2 pp.
A mobile (45,000 pound) barker-chipper manufactured by Cargate Westminster Industries, Ltd., New Westminster, B. C., Canada. The unit includes a ring barker, chipper cutoff saw, and transfer and infeed chains, all mounted on a wheeled trailer and powered by a 350 to 400 hp. diesel engine. Logs up to 12 inches in diameter can be chipped. Logs are fed to the machine at 130 lineal f.p.m. The manufacturer reports that chips do not require screening and can be blown directly into a van for transport to the mill.

Anonymous. 1966. DOMTAR ROADSIDE CHIPPING PLANT PRODUCES 10-12 OVEN DRY TONS PER HOUR. Can. Forest Ind. 86(9): 18-21.
Designed to debark and chip tree-length pulpwood in the field, the portable system eliminates log handling and reduces storage costs. Power for the chipper, accessory feeds, and conveyors is provided by a lightweight gas turbine aircraft engine. A Soderhamn H-P (horizontal/parallel) twin-disk chipper is used. The wafer-type chips produced are reported to have superior pulp-making qualities. The mobile chipping system can feed to conventional chip transport trucks or to chip pipelines.

Anonymous. 1966. THE UTILIZER III. Pulp and Pap. 40 (45): 11.
The Utilizer III, a mobile barker-chipper manufactured by Crown Zellerbach Corporation and Nicholson Manufacturing Company, Seattle, has a production rate from 80-100 units per shift (a unit is approximately equal to a cord of pulpwood) and can process logs as small as 2 inches in diameter. Logs from 6 feet to full tree length can be fed continuously into the barking and chipping units at 85 f.p.m. The unit weighs 86,000 pounds and is self-propelled.

Anonymous. 1966. TURBINE ENGINE POWERS PORTABLE ROADSIDE CHIPPER. Can. Pulp and Pap. Ind. 19: 45-46.
An experimental, logging-site, tree-length, pulpwood chipper (Soderhamn H-P twin-disk) is powered by a modified gas turbine aircraft engine. The aircraft engine has ideal torque characteristics for this application.

Anonymous. 1967. MOBILE CHIPPER PROCESSES NEW ENGLAND PULPWOOD. Forest Ind. 94(11): 60-61.
A Nicholson Utilizer mobile barker-chipper has been working at both woods and log yard locations near Groveton, New Hampshire, since it was delivered in the fall of 1966 to Cloutier Lumber Co., Inc. The equipment debarks and chips both hardwoods and softwoods. Stated production on mixed hardwoods and softwoods is 100 cords per 8-hour day on logs averaging 20 feet in length. A hydraulic crane places the logs one at a time on the Utilizer's infeed conveyor. The ring-type barker is a 26-inch, five-knife unit. The chipper is a 22-inch, 12-knife, V-drum machine and the bark hog is a horizontal disk type. Feed speed is 85 f.p.m. —even on frozen wood. Minimum log diameter is 4 inches and minimum log length is 6 feet. Two 435 hp. diesels drive the chipper, and one 345 hp. motor-generator set provides power for the other components. Chips are blown directly into waiting trailers.

Grant, S. E. 1966. SOME MECHANIZED PULPWOOD UNITS AT A GLANCE. Pulp and Pap. 40(46): 47.
Operating and purchase costs, dimensions, capacity, and power of seven mechanized pulpwood units are listed in chart form. Units described are: Utilizers I, II, and III manufactured by Nicholson; Bark-chipmobile manufactured by Port City Steel; a semiportable chipping mill by Carthage Machine Company; Cargator by Cargate, Westminster Industries; and a machine manufactured by Forano, Ltd. and Soderhamn.

Logan, B. A. 1966. THE EVOLUTIONARY PROGRESS OF TREE-LENGTH BARKING AND CHIPPING. Pulp and Pap. Mag. Can. 67(9): WR435-WR449.
Records Domtar's efforts to develop a year around, round-the-clock, cheap, tree-length harvesting process. Domtar desires the system to work as close to the stump as possible, in a flat clay belt area where gravel for road building is scarce. Four stages of evolution are envisioned, as follows:

Stage I—Roadside chipping (winter or summer).—Manually felled and branched tree lengths skidded in concentrations of 2,000 cords or more. Chipped and blown into vans on a gravel road.

Stage II—Chipping along a bulldozed trail.—Manually felled and branched tree lengths skidded into concentrations of 2,000 cords or more. Chips are blown into a chip container for forwarding and dumping into a van on the truck road.

Stage III—Strip trail chipping.—The barker-chipper self-propelled unit moves along in the stump area from pile to pile of bunched wood. Felling, branching, and bunching is done by a processing unit of the Beloit Spruce Harvester Type. The chips are blown directly into container forwarders and taken to the truck road for dumping into vans.

Stage IV—Processing at the stump.—One machine shears off the tree and completes all the processing functions of branching, debarking, chipping, and blowing into a container. Uses Stage III forwarding system.

MacArthur, J. D. 1966. DOMTAR'S HOT CHIPPING OPERATION. Pulp and Pap. Mag. Can. 67(10): WR504-WR506.
Domtar has developed a portable barking and chipping machine to transform tree-length logs into pulp chips at roadside. The machine consists of live deck, infeed conveyor, Cambio 18-inch barker, bark conveyor, and Soderhamn H-P twin-disk chipper. Power is supplied through V-belts to the chipper by a Pratt and Whitney ST6 gas turbine engine that weighs 290 pounds and generates 450 hp. The turbine also runs a 75 kw. generator to operate all other components. Infeed conveyor speed is 150 linear f.p.m. Logs up to 17 inches can be accepted. The complete machine is mounted on five portable pallets.

Peterson, H. W. 1966. CROWN-ZELLERBACH'S MOBILE WOODS CHIPPER PUTS PROFIT IN SALVAGE WOOD. Can. Forest Ind. 86(9): 22-23.
To economically harvest small and salvage wood from the timber forests on the Pacific coast, Crown Zellerbach Corporation has developed a self-propelled chipping plant designed to process wood in the field. Known as the Utilizer, the unit consists of a log loader, delimber, debarker, and chipper. It can process logs from 2.5 up to 14 inches in diameter. The chips are blown into a chip van towed by the machine. One man (housed in a cab) controls all functions of the machine including propelling and steering.

Storgards and Blomquist. 1967. (Barking)

GRINDING

Fujii, J. S. 1964. MOLECULAR DEGRADATION CAUSED BY VIBRATORY BALL-MILLING OF WOOD. Ph.D. Thesis. State Univ. Coll. Forest. at Syracuse. Ann Arbor Univ. Microfilms. 1966. 110 pp.
A study of the response of wood to mechanical action. The extent of molecular degradation caused by mechanical treatment in a vibratory ball mill is used to measure the ability of samples to absorb energy through deformation on the microscopic and submicroscopic levels. Based on the known features of mechanically induced degradation, the concept of microplasticity has been developed and experimentally demonstrated. It is shown that the nature of the liquid in which the sample is dispersed during milling has a profound effect on the rate of degradation. Molecular degradation during milling decreases in the order benzene > methanol > water and is clearly the result of enhanced swelling and plasticity as one moves from benzene to water. Microplasticity is improved if lignin is removed from the wood and the resulting holocellulose is milled in water. An intensive examination of the influence of the hemicelluloses has shown that removal of xylans has no apparent effect, whereas removal of glucomannans leads to significantly diminished microplasticity.

DEFIBRATING

Anonymous. 1967. PULPSTONE SPEED CHART. PULPSTONES FOR THE PAPER INDUSTRY. Worchester, Mass. Norton Company.
A 1-page nomogram relating diameter and r.p.m. of the pulpstone to surface speed in f.p.m. Speeds in excess of 6,000 surface f.p.m. should not be used unless recommended by the manufacturer.

Gavelin, N. G. 1966. GRINDING VARIABLES AND THEIR EFFECT ON MECHANICAL PULP QUALITY. Pap. Trade J. 150(11): 53-59.
A guide for regulating pulpstone grinding variables for desired groundwood quality and production rate. Topics include pulpstone peripheral speed, grinding pressure, pulpstone surface characteristics, grinding temperature, energy consumption, and the use of pitless grinding and pulpstone showering. Sixteen references.

Gavelin, N. G. 1966. PULPSTONES FOR PRODUCTION OF MECHANICAL PULP. Pap. Trade J. 150(9): 41-43.
Cement and ceramic pulpstones are compared, pulpstone installation and sharpening procedures are reviewed, and pulpstone specifications (particularly hardness, grit size, grit hardness, and stone strength) are defined and examined.

Gavelin, N. G. 1966. SCIENCE AND TECHNOLOGY OF MECHANICAL PULP MANUFACTURE. 245 pp. New York: Lockwood Publishing Co., Inc.
A 14-chapter book with introduction in which Douglas Atack states that disk refining of wood chips or residuals is the most revolutionary innovation in the field of mechanical pulping since the introduction of the commercial stone grinder by Voelter and Voith in 1856. In the 5 years since its commercial inception, disk refining has become an established pulping process which in 1966 accounted for just over a million tons, or about 5 percent of the world production of mechanical pulp. Chapters of the book are headed: (1) Broad look at developments in production of mechanical pulp. (2) Theory and practice in grinding wood. (3) Reappraisal of grinders for mechanical pulp. (4) Grinding variables and their effect on quality. (5) Pulpstones for mechanical pulp. (6) How to measure mechanical pulp quality. (7) Problems of mechanical pulp quality. (8) Wood, raw material for mechanical pulp production. (9) Current trends in mechanical pulp mill design and operation. (10) Fundamentals and latest developments in mechanical pulp screening. (11) Refining screen rejects to make usable pulp. (12) Current trends in methods of bleaching mechanical pulp. (13) Thickening, storing, and drying pulp for shipment. (14) Current status of mechanical pulps from chips. (15) Chemi-mechanical pulping processes.

Korda. 1966. (History and General Texts)

McIntosh, D. C. 1967. THE EFFECT OF REFINING ON THE STRUCTURE OF THE FIBER WALL. TAPPI 50(10): 482-488.
Loblolly pine chips taken from the 11th to 20th rings of a single 24-year-old log were pulped by the peracetic-acid holocellulose method, with cooking time extended so that defibration was complete without mechanical treatment (60 percent yield). Earlywood and latewood fibers were pulped separately. Refining was done in an FPI mill. Micrographs showed that refining delaminated the wet fiber wall into many lamellae. The author speculates that the two or three zones of very easy cleavage within the fiber wall may be the result of metabolic inactivity at night during the period of cell-wall growth.

Mette, H., and Kommert, R. 1964. ABRASION RESISTANCE OF SPRUCE WOOD. Wiss. Z. Tech. Univ. 13(2): 615-618. Dresden.
In groundwood pulp tests on clear specimens of 29 trees from three sites, resistance to grinding perpendicular was not significantly correlated with density at either 12-percent moisture content or saturation. Effect of changes in grain direction and wood structure caused by knots affected resistance.

Paterson, H. A. 1967. RELATIONSHIP OF GROUNDWOOD FREENESS AND BURSTING STRENGTH. C.P.P.A. Tech. Sect. Data Sheet, B-1 to B-1C, 4 pp. Mersey Pap. Co., Ltd.
The relationship between Canadian Standard Freeness and bursting strength is given in graphical form. The charts are useful for comparisons of wood, grinder stones, and process variables in terms of products. They are based on a large number of tests and appear to hold for a wide range of grinding conditions at widely separated mills.

Reinhall, R., and Vardheim, S. 1965. THE DEFIBRATOR PROCESS IN THE MANUFACTURE OF SEMICHEMICAL PULP, REFINER CHEMIGROUNDWOOD, AND REFINER GROUNDWOOD. Wochenbl. für Papierfabr. 94(5): 146, 148, 150.

Wardrop. 1966. (Properties of Wood)

PROPERTIES OF THE CUTTING EDGE AND CUTTER

TOOL MATERIAL

Anonymous. 1967. (History and General Texts)

Barz, E. 1966. PROLONGED SERVICE LIFE OF WOODWORKING TOOLS BY HARD-CHROMIUM PLATING. Holz als Roh- und Werkstoff 24(12): 592-597.
After preliminary treatment, unalloyed, light-alloy, and high-speed steel were suitable for hard-chromium plating. Hard-chromium plating was recommended for woodworking tools sharpened only at the face or back and where tipping with carbide was unsuitable. Sharpening chromium-plated knives only on the front face produced a self-sharpening effect that prolonged service life. Longer wear of hard-chromium plated tools was attributed to reduction of friction and passiveness towards chemical and electrochemical attacks.

Booth, H. E., and Sulc, V. 1966. CHROMED SAWS IN N. S. W. SAWMILLS. Australian Timber J. 32(7): 57-59, 61.
Reviews the use of chromium-plated circular saws for milling hardwoods in New South Wales and gives recommendations for their sharpening and setting.

Byzov, V. I., and Dem'janovskij, K. I. 1966. FITTING SAW TEETH WITH (TIPS OF) HIGH-SPEED STEEL AND HARD ALLOYS. Les. Zh. 9(4): 97-102.
Describes a technique for welding tips of hard alloy or high-speed steel to the sides of saw teeth. Weld strength proved adequate, and trials with circular and frame saws tipped in this way showed that tooth wear was considerably reduced. Sawing accuracy greatly increased.

Jones, D. S. 1965. CEMENTED TUNGSTEN CARBIDE IN THE WOODWORKING INDUSTRY. Australian Timber J. 31(8): 37-39,

40, 44.
Cemented tungsten carbide woodworking tools should be used when severely abrasive conditions exist and when there is sufficient workload to offset the initial cost. In machining plywood radio cabinets, one cemented carbide tool did the work of 64 high-speed steel tools with costs at a ratio of 1 to 15; in sawing laminated wood, steel teeth required 80 sharpenings for each sharpening of tungsten carbide teeth. Cemented carbides have high temperature hardness and can cool at any speed from high temperatures without deterioration. For most purposes, only 6 or 7 inches of cemented carbide can be attached to a steel body without cracking or warping. Warping can be overcome by a shim, or mesh, in the braze layer, or in some cases by using solid carbide knives. Cemented tungsten carbide had higher compression strength, but lower tensile strength and shock resistance than steel. In cutting edges of cemented carbide, compression should be utilized in preference to tension; bending and vibration should be minimized. Carbide knives reduce vibration in tools. Wear of tungsten carbide cutting edges occurs in three stages: rapid wear during the removal of initial roughness left from sharpening, slow frictional wear, and breaking away of carbide particles. Tools should be removed before the onset of the last stage. Carbide edges have a high degree of keenness, but not as high nor as free of defects as steel edges. Under favorable conditions, the average sharpness of carbide edges over a long period will be better than steel edges.

Juvonen, R. 1966. HARDNESS OF THE SWAGE SET FRAME SAW BLADES. Paperi ja Puu 48(4): 255-257, 259-262.
Swaging and shaping are done in one operation in a new method developed at the State Institute for Technical Research in Helsinki. The most serviceable primary hardness of frame-saw blades when using this method was determined. In sawing tests, 36 to 47 H_{RC} proved suitable, but the 47 H_{RC} blades were prone to break on the cutting edges and the 36 H_{RC} blades tended to bend and wear on the tooth point. In sawmill use, 40 to 42 H_{RC} blades were more easily swaged than harder blades, swaging tools lasted longer, swaging was deeper, and the number of sharpenings between each swaging increased to six or seven.

Olszewski, J. 1965. CIRCULAR SAWS WITH CERAMIC TEETH FOR CUTTING PARTICLE BOARD. Przem. Drzewny (11): 410-413.
Describes a series of Polish investigations on the design and operation of eight-toothed circular saws with ceramic teeth, locally manufactured by fusing Al_2O_3 and unspecified plasticizers. The inserted teeth were fixed with epoxy glues or by mechanical means; their sharpness angle was 65°. In trials of sawing boards of density 0.613 at a saw speed of 60 m. per second, the effective duration of sawing was approximately 70,000 m. with 0.196 mm. feed per tooth and 58,000 m. with 0.563 mm. The trials indicate that these ceramic teeth can be used for cutting particleboards, though further research on the ceramic material, and on tooth and saw design are necessary.

Trubnikov. 1965. (Properties of the Cutting Edge and Cutter; Stability)

DULLING

Anonymous. 1967. SHARPNESS OF PAPER TRIMMING KNIVES AND THE WEAR OF ITS CUTTING EDGE. Jap. Pulp Pap. 5(1): 86-88.
The wear of a paper trimming knife was shown to be primarily a function of knife hardness. Abrasiveness of the paper (influenced by fibers, fillers, etc.) was also a factor. Knives of varying hardness made from Cr-W finishing tool steel were used to cut 1,000 thicknesses (sheets) of newsprint. The increase in bluntness of the knife as it wears is illustrated.

Anonymous. 1966-1967. THE WEAR OF SAW TEETH. CHAPTER I. THE NEED FOR A STUDY OF WEAR AND THE CHOICE OF A METHOD. Bois Forets Trop. 1966(110): 57-66; 1967(114): 65-72; 1967(115): 55-67.

Alekseev, A. V. 1957. IMPROVING THE RESISTANCE TO WEAR OF PLANING BLADES. Derev. Prom. 6(7): 13-16. *(Also* CSIRO Australian Transl. 6671.)
Cutting edges of U8GA toolmaking carbon steel were microgeometrically analyzed after planing birch. Wear resulted in the formation of a groove on the front side of the blade and a land on the back side which gave a self-sharpening effect. This pattern of wear was independent of surface fineness of cutting edges and method of strengthening. Cutting angles (?) in the range of 55 to 85° and thickness of layer that was removed had no effect on the microgeometry of the blades due to wear, although cutting angles of 75° and sharpening angles (?) of 60° were advantageous. A sequence of changes in the microgeometry of blades during wear was attributable to the way the blades were manufactured and hardened. Values of wear and blunting parameters depended upon length of the cutting path. A microbevel 0.3 mm. wide on the back side of jointed knives did not improve surface quality, but did reduce wear as much as 20 percent. Alloying the surface layer of the tool cutting face during hardening by electric sparks or electric arc in nitrogen gave the woodcutting tool greater resistance to heat. Plating blades with a thin layer of chromium improved resistance to wear three to four times. Hardening by electrical means increased blade resistance to wear by 30 to 40 percent. Sulphidizing at moderate temperatures and parkerizing (rustproofing) were advantageous with blades made of carbon-steel.

Barz, E., *et al.* 1965. I. WORKING PROPERTIES OF DISK-SHAPED TOOLS. II. CUTTING TESTS ON GLUED WOOD-BASED MATERIALS. Forsch. des Landes Nordrhein-Westfalen, Koln No. 1164, 90 pp.

Chardin, A. 1966. THE WEAR OF SAW-TEETH. PART I—THE NEED FOR A STUDY OF WEAR AND THE CHOICE OF A NEW METHOD. Bois Forets Trop. 110: 57-66.

Cuprin, V. I. 1966. EFFECT OF CUTTER BLUNTING ON THE CUTTING FORCE AND THE REDUCED COEFFICIENT OF FRICTION. Lesnaya Prom. (6): 23-24.

Fergin, V. R. 1966. WEAR AND BLUNTING OF THE CUTTING INSTRUMENT DURING WOOD TURNING. Les. Zh. 9(5): 98-103.
Develops, by means of integral calculus, expressions that enable cutter blunting to be taken into account when establishing turning schedules.

Melehin, L. F. 1965. THE QUESTION OF 'ACCIDENTAL' WEAR OF SAW TEETH. Les. Zh. 8(4): 92-99.

Nosovskij, T. A. 1967. THE THRUST FORCES IN CONNECTION WITH THE BLUNTING OF A WOOD CUTTING TOOL. Les. Zh. 10 (4): 108-112.

Pahlitzsch, G., and Jostmeier, H. 1966. INFLUENCE OF PARTICLE BOARD STRUCTURE ON "STANDING TIME" (A MEASURE OF THE TIME IT TAKES FOR THE TOOL TO DULL) WHEN CLIMB CUTTING WITH SINGLE-EDGE FINGER CUTTERS. Holz-Zentralbl. 92(11): 197-199.

Yamaguchi, K., and Aoyama, T. 1962. THE BLUNTING OF TUNGSTEN CARBIDE TIPPED CIRCULAR SAWS. Government Forest Exp. Sta. Bull. 138, pp. 121-145. Tokyo.
Saws with tungsten carbide tips were more effective for

sawing abrasive species than steel saws. When tips of different hardness were tested, harder tips had longer useful life. Amount of tooth wear, necessary to cause woolly fibers and detachments of wood on the lower edge of the sawn timber, was found to be similar for different teeth regardless of quality of the tip and the number of teeth. Wear of the tooth point was 0.07 mm. and of the tooth corner 0.045 mm.

Zajcev, N. A., and Smolin, M. D. 1967. THE WEAR OF CIRCULAR SAWS WHEN SAWING PARTICLE BOARDS. Derev. Prom. 16(2): 8-10.
Investigations indicate that the thermodiffusion of carbon into the region of the cutting edge is the main cause of wear.

FITTING AND SHARPENING

Anonymous. 1966. CHAIN SAW SHARPENER. Timber Trades J. 258(4697): 74.
A simple tool re-forms the cutting edge of the link without removing excessive material. Rotating under pressure, the file partially cold-forges the link. The instrument holds the chain firmly during operation.

Anonymous. 1967. A REPORT ON HEAT TENSIONING. Forest Ind. 94(10): 99.
Describes a technique for heat-shrinking circular saws and bandsaws through application of an oxyacetylene torch. Torch tips are positioned so that ¼-inch carbonizing flames heat a narrow zone on the saw about ⅝ inch below the gullet. Temperatures should range from 550 to 900° F. When the proper amount of heat is applied, the saw will shrink where it has previously been stretched by mechanical tensioning, and elasticity will be returned to the steel. The saw is power-fed at a controlled rate past the torch tips to control heating rate.

Alexandru, S., Dogaru, V., and Tudor, E. 1966. THE TENSIONING OF BANDSAW BLADES USED IN SAWMILLS. Ind. Lemnului 17(6): 221-225.
Theoretical discussion, with practical recommendations.

Bajkowski, J. 1967. THE EFFECT ON RIGIDITY OF FRAME SAW BLADES OF PRESTRESSING BY ROLLING. Holztechnologie 8(3): 194-199.

Barz, E., and Hoptner, H. G. 1966. THE INFLUENCE OF TOOTH SHAPE AND NUMBER OF TEETH OF CIRCULAR SAWBLADES ON THEIR WORKING BEHAVIOR. Holz als Roh- und Werkstoff 24(4): 144-154.
For every circular saw blade, there was only one optimum range of operation where energy consumption was minimum and surface quality was satisfactory. The optimum range depended on the geometric dimensions of the blade, cutting geometry, condition of stress, condition of set, cutting velocity, feed rate, feed per tooth, and properties of the wood. Every saw blade had a minimum power requirement. Saws with small numbers of teeth produced poorer surfaces than saws with large numbers of teeth. Power consumption was dependent upon the cutting velocity. Cutting velocities and feed rates had a remarkable effect on the surface quality. By appropriately choosing cutting and feed velocity, instability was avoided. Optimum tooth shape for longitudinal cutting had a clearance angle of 15° and a rake angle of 20°.

Borovikov, E. M. 1965. INFLUENCE OF THE PLASTIC DEFORMATION OF THE METAL OF TOOTH TIPS DURING SWAGING ON THEIR WEAR AND BLUNTING. Les. Zh. 8(1): 116-126.
Experiments were made to compare frame-saw teeth: (a) cold-swaged and shaped, and (b) cold-swaged and shaped but the increased steel hardness associated with swaging completely removed by repeated heat treatment. Cold swaging not only reduced tooth wear and blunting, but also prevented "ovaling" along the length of the main cutting edge, improved kerf surface smoothness, and reduced the sawing power requirement. Cold-swaged saws can be left to run longer between sharpenings. Comparative data on the mean and maximum cutting force, mean feed force, and specific work in sawing are shown in graphs.

Danielsen, B. S. 1966. METHODS OF GRINDING TUNGSTEN CARBIDE TIPPED TOOLS. Woodworking Ind. 23(11): 22-24.
Discusses different grinding methods and grinding wheels for sharpening carbide tools. Grinding with cup wheels has economic advantages. If periphery wheels are used, feed should be parallel with the edge of the tool, and high specific loads close to the cutting edge should be avoided. Thin planer knives and similar tools can advantageously be resharpened with periphery wheels feeding parallel to the edge. Periphery wheels feeding perpendicularly against the edge should be used only in profile grinding. Resharpening with 600-grit diamond wheels is not economical, except where there are special demands on wearability characteristics of tools. At present, 400-grit diamond wheels are the coarsest that can be used to give an edge suitable for most applications. It was recommended that 220-grit wheels be replaced by 400-grit. The method of resharpening with silicon carbide wheels and hand lapping with a diamond stone should not be used on high-grade carbide tipped woodworking tools.

Dem'janovskij, K. I., and Dunaev, V. D. 1965. SHARPENING WOOD-CUTTING TOOLS. 202 pp. Izdatel'stvo 'Lesnaja Promyslennost'. Moscow.

Dobrynin, E. D. 1967. INVESTIGATION OF THE STRENGTH OF THE BRAZED JOINT IN BAND SAWS. Les. Zh. 10(1): 98-99.
A coal-fired furnace produced weaker joints than a charcoal-fired furnace when brazing was done with copper/zinc solder. Joints of both types were weaker than those produced by an electric welding unit.

Doncev. 1965. (Sawing; Bandsawing)

Feihl and Godin. 1967. (Veneer Cutting)

Fukui. 1967. (Sawing; Circular Sawing)

Kempe. 1964. (Shearing)

Nikolic. 1965. (Sawing; Chain Sawing)

Plehn, H. J. 1967. THE FRONT FACE ANGLE OF THE SET TOOTH AT STRAIGHT SHARPENING. Holz als Roh- und Werkstoff 25(4): 135-137.
Setting results in a slight, but not negligible, deviation in the sharpening angles. When straight-sharpened, the angles of the front and the back faces are no longer exactly 0° after setting. This deviation can be calculated. Includes an easily remembered rule of thumb as well as a table containing values gathered from practical experience.

Porter. 1966. (Sawing; Sash Gangsawing)

Postnikov. 1966. (Sawing; Sash Gangsawing)

Sivak. 1966. (Sawing; Sash Gangsawing)

Stahiev, J. M. 1966. DETERMINING THE OPTIMUM LOCATION AND WIDTH OF THE ROLLER-TENSIONING ZONE IN CIRCULAR SAWS. Lesnaya Prom. (11): 23-25.

Stahiev, J. M. 1966. EFFECT OF ROLLING ON THE STRESS STATE OF CIRCULAR SAWS. Les. Zh. 9(1): 112-114.
Electrical tensometry was used to measure the stresses produced in circular saw blades by rolling. For blades 500 mm. in diameter and 2.2 mm. thick, the creation of tan-

gential tensile stresses of approximately 340 kg. per square centimeter will completely compensate the compressive stresses caused by a temperature gradient of 20° C. in the saw.

Timonen, S. M. 1965. EFFECT OF SHARPENING-SCHEDULE FACTORS, WHEN USING AN ABRASIVE DISK, ON THE PHENOMENON OF SCORCH AND THE DEGREE OF SMOOTHNESS OF THE SHARPENED SURFACES. Les. Zh. 8(2): 94-98.
Investigates the effect of disk speed, longitudinal feed speed, and the thickness of the metal layer removed, in sharpening woodworking tools.

Trubnikov, I. I. 1965. STRESSES IN BAND-SAW BLADES SUBJECTED TO SURFACE TENSIONING. Les. Zh. 8(2): 104-108.
A special roller was installed below a bandsaw so as to press against the moving blade. Roller pressure on the blade could be varied. Strips cut from the blade assumed a curvature directly proportional to the roller pressure. Stresses in the rolled layer were investigated by removing successive layers of metal from the pressed surface and then determining the resultant changes in strip curvature. Graphs show the total stresses resulting from rolling and from bending on the pulley, and also the total stresses in the straight part of the blade between the pulleys. Magnitude of stresses depended on roller pressure. Stresses were maximum at the rolled surface, decreasing smoothly and becoming tensile at a certain depth.

Tverdynina, M. M. 1966. CHECKING ON THE TENSIONING OF CIRCULAR SAWS BY MEASURING SAG ALONG THE PERIPHERY OF THE DISK. Derev. Prom. 15(3): 12-14.
Formulae are developed for calculating critical temperature of the blade periphery, i. e., the temperature at which the blade loses its elastic equilibrium stability; critical temperature stress on the blade center; initial deformation by tensioning; critical initial deformation by tensioning; and the theoretical amount of sag along the periphery of an untensioned blade. Tensioning increased critical temperature of blade periphery. The degree of tensioning (as expressed by blade sag) can thus be evaluated by comparing calculated values of this parameter with measured values. This was done for 18 saw blades 500 mm. in diameter and 2.2 mm. thick, tensioned by an expert saw-doctor and assessed by him as well prepared. Values of critical initial deformation and of critical temperature were almost identical for these 18 blades, thus confirming the saw-doctor's assessment. Calculated values of critical temperature were compared with values measured on a special test-rig (described), and found to agree satisfactorily. A special rig for measuring blade sag is also described, and recommendations are made for tensioning.

Wuster, E. 1966. CALCULATION OF THE STRESSES IN GANGSAW AND BANDSAW BLADES CAUSED BY TENSIONING. Holz als Roh- und Werkstoff 24(4): 134-144.
For stiffening, blades of mechanical saws are tensioned, i. e., their central zones are expanded between small pressure rolls or by hammer blows. This permanent deformation causes stresses within the saw blades. Several authors have tried to calculate these stresses on the basis of the magnitude of transverse curvature, the so-called drop, occurring when bending a tensioned saw blade by hand. Erroneously, calculations were always based on the implicit assumption of infinitely thin saw baldes. Hence, the resistance against transverse bending of the saw blades was neglected. In fact, the stresses caused by tensioning are much greater. Methods for calculation (and values) of the actual stresses caused by tensioning gang- and bandsaw blades are shown.

Wuster, E. 1966. THE CHANGE OF THE STRETCHING FORCES OF FRAMED SAWS UNDER THE INFLUENCE OF CUTTING FORCES. Holz als Roh- und Werkstoff 24(5): 212-216.
Change of stretching forces of pretensioned saws was investigated when resistance of the workpiece acts on the blade. The increase of stretching force on the tooth edge of the saw amounts to a few percent in very elastic frames (log and carpenter saws) and reaches the entire value of the cutting resistance in a rigid frame (gangsaw). A mathematical function was developed, dependent upon the point at which the cutting resistance acts and the rigidity of the frame, to determine the cutting resistance of a framed saw that would compensate completely for the stress in the trailing part of the blade.

STABILITY

Ablamowicz-ledwon, J. 1965. SOME RESULTS OF INVESTIGATIONS INTO THE DAMPING OF THE ACOUSTIC VIBRATIONS OF CIRCULAR SAWS BY MEANS OF A MAGNETIC FIELD. Przem. Drzewny 16(4): 139-140. (Also translated by Furniture Ind. Res. Assoc. 1966.)

Axelsson. 1967. (Sawing; Chain Sawing)

Barz, E. 1965. CIRCULAR SAW BLADES HAVING PERFORMANCE CHARACTERISTICS THAT ARE INDEPENDENT OF RESIDUAL STRESSES. Holz als Roh- und Werkstoff 23(12): 484-491. (Also translated by Can. Dep. Forest. No. 58. 1966.)

Demsky. 1967. (Sawing; Circular Sawing)

Duclos. 1967. (Sawing; Circular Sawing)

Jones, D. S., Hawkins, B. T., and McArthur, E. 1966. EXPERIMENTAL ANALYSIS OF SAW TOOTH STRESSES AND DEFLECTION. Forest Prod. J. 16(11): 35-44.
To determine the design criteria necessary to promote stiffness in a sawtooth, stresses in steel sawteeth arising from lateral load were determined, using both the brittle lacquer and photoelastic techniques. Deflections at sawtooth tips were measured. Since the maximum value of lateral stress occurred at the lower front of the conventional Australian tooth profile, stress was reduced by applying reinforcement in this region. Such reinforcement reduced deflection most when its location was moved closer to the tip. While the "denture a coupeau projete" satisfied both of these criteria, undesirable stress concentrations were present and sharpening difficulties could arise. Consequently the "denture perroquet" appeared more desirable. Stresses arising from parallel and normal loads were estimated for the conventional profile and for the "denture a coupeau projete," and were compared with stress from lateral load for measured values of parallel, normal, and lateral loads. Both normal and parallel stress were about three times higher in the latter profile than in the former. Lateral stress was low compared to normal and parallel stress in the latter profile, but was often in excess of them in the conventional profile. The "denture perroquet" again appeared to be favorable when considered from the viewpoint of stress due to combined loads. As a result of these studies the "denture perroquet" is considered to have excellent stress distribution and stiffness and is now being generally recommended to the Australian sawmilling and woodworking industries.

Kafka. 1965. (Sawing; Sash Gangsawing)

Lapin. 1967. (Sawing; Sash Gangsawing)

Pahlitzsch, G., and Rowinski, B. 1966. VIBRATION BEHAVIOR OF CIRCULAR SAW BLADES. PART I—DETERMINATION AND EFFECTS OF GEOMETRY AND PRESTRESSING CONDITIONS OF

SAW BLADES. Holz als Roh- und Werkstoff 24(4): 125-134.
Causes of vibration were examined on a modified circular sawing machine. Installed roller bearings caused undesirable axial movements of the shaft. Deviations of the cutting edges from the ideal rotational line affected the vibration of the saw blade during cutting and should be kept as small as possible. Prestressing conditions were determined by means of strain gauges in radial and tangential directions. Compression stresses produced in the saw blade by prestressing caused a 10-percent displacement of the natural frequencies of the blade. Back-stressing by rolling immediately below the tooth bases diminished natural frequencies and increased tensional stresses in the blade rim. Further prestressing eliminated high-frequency vibrations causing whistling.

Pahlitzsch, G., and Rowinski, B. 1966. VIBRATION BEHAVIOR OF CIRCULAR SAW BLADES. PART II—DETERMINATION OF THE CRITICAL ROTATION SPEEDS AND NATURAL FREQUENCIES OF SAW BLADES, AND THEIR EFFECTS. Holz als Roh- und Werkstoff 24(8): 341-346.
Theory of vibration in a plate was adapted to explain the causes of vibration in an idle-running saw blade. Investigations showed that first-line natural frequencies excited in the saw blade are determined by a vibrational form with a diameter of one node ($k = 1$). As an exciter frequency, the revolving frequency with its first four harmonics was determined. The vibrational form with $k = 2$ was observed, but its critical speed often coincided with that of the vibrational form $k = 1$. With cutting rates of more than 100 m. per second, critical speeds occur causing natural vibrations with $k = 2, 3, 4$ . . . and extremely high amplitudes. Critical speeds could be determined from the thickness and diameter of the saw blade. Critical bending speeds of the saw-shaft occurred within the range of 1,000 to 7,000 r.p.m. where extremely high double amplitudes were observed.

Pahlitzsch, G., and Rowinski, B. 1967. ON THE VIBRATION OF CIRCULAR SAW BLADES. PART III—VIBRATION OF THE SAW BLADES DURING CUTTING AND THEIR DAMPING. Holz als Roh- und Werkstoff 25(9): 348-357.
Vibrations of saw blades during cutting or during idle running are always the result of natural vibrations of the saw blade. They show a resonance related to r.p.m. and the number of acting teeth. Outside the resonance the saw blade is only excited by the force of the sawing teeth and vibrates with small amplitudes only. It is significant that natural vibrations are excited on saw blades with straight-ground teeth (back and face) only if the frequencies of the acting teeth are very close to a natural frequency related to the number of revolutions. These conditions have a considerably less favorable effect on set rather than on unset saw blades. Saw blades with bevel grinding will be excited in natural vibrations even if the difference between the frequency of acting teeth and the natural frequency related to the number of revolutions is relatively large. Since with the increased r.p.m. and number of teeth only natural vibrations of a higher order may be excited with the respective small vibration amplitudes, these cutting conditions are to be given preference. As far as possible a large feed per tooth should be chosen, since in the case of small feeds per tooth and under unfavorable conditions the saw blade exhibits free vibrations. The natural vibrations can be damped by using larger cutting depths and by slotting the saw blade. Bevel angles on the back or face always cause unfavorable vibration behavior. In view of the vibration behavior, thin or standard-size saw blades do not necessarily have to be less advantageous than thick saw blades, because the vibrations of thin saw blades may be damped by less forces.

Pahlitzsch, G., and Rowinski, B. 1967. ON THE VIBRATION BEHAVIOR OF CIRCULAR SAW BLADES. PART IV—CAUSES OF THE WHISTLING OF CIRCULAR SAW BLADES AND MEASURES FOR ITS AVOIDANCE. Holz als Roh- und Werkstoff 25(10): 393-397.
The vibration behavior and the causes of vibration of circular saw blades have been systematically investigated during idle running and during cutting. This part deals with the high-frequency vibrations (whistling) of saw blades during idle running. It was shown that high-frequency vibrations are self-excited natural vibrations of the saw blades, the frequency of which is independent of the number of teeth. The formation of these high-frequency vibrations during idle running depended upon the size of the tooth surface and the forces of air acting on them. The tooth angles and tooth excess (?) did not exert any considerable influence. Straightening and prestressing by the saw blade manufacturer always cause a few saw blades of a series to whistle, and these sometimes at a certain number of revolutions only. It is possible to minimize the tendency of a saw to whistle by constructive measures during the saw blade manufacture. Among the three measures of damping suggested, i. e., a reduced number of teeth, intense and constant prestressing by rollers, and slip joint (?) of greater lengths than hitherto applied, the latter is the most effective one, all the more so because with slip joints more favorable results are also obtained during cutting. (From author's summary.)

Porter, A. W. 1965. IMPROVING THE EFFICIENCY OF FRAME SAW BLADES. New Zeal. Forest Res. Inst. Res. Leafl. 11, 3 pp.
Examines the cause of one sort of wavy-edge sawing and shows that the two main factors affecting blade rigidity, and hence straightness of sawing, are buckle pull and blade length.

Porter. 1966. (Sawing; Gangsawing)

Stahiev, J. M. 1967. THE RIGIDITY OF CIRCULAR SAW BLADES FOR CUTTING WOOD. Les. Zh. 10(4): 113-115.

Sugihara, H. 1965. THE INFLUENCE OF TEMPERATURE ON THE STABILITY OF SAW BLADES. *In* IUFRO Proc. 1965, Vol. 3, Sect. 41, 8 pp. Melbourne.
Discusses the problems involved in determining the influence of temperature on stability and methods of diminishing its influence.

Szepesi, L. 1965. VIBRATION IN POWER SAWS: SOME ADDITIONS TO PREVIOUS TEST RESULTS. Erdö 14(10): 444-450.
Tests of seven chain saws indicated that vibrations increased with reduced weight of saw and that in many cases they were dangerous to health. Frequent change of operators is recommended.

Thunell. 1966. (Nomenclature)

Thunell. 1966. (Sawing; Sash Gangsawing)

Thunell, B. 1967. FACTORS AFFECTING DIMENSIONAL ACCURACY WHEN SAWING ROUNDWOOD ON HIGH-PERFORMANCE SAWS. Schweiz. Z. Forstw. 118(7): 415-434.

Trubnikov, I. I. 1965. FATIGUE FAILURE OF BAND-SAW BLADES. Les. Zh. 8(6): 91-93.
The fatigue strength of pieces cut from a blade 1.6-mm. thick and 230-mm. wide, tested in a symmetrical stress cycle, was 43 kg. per square millimeter. From other Russian work, maximum stress in the outer layer of the blade is known to be 32, and minimum stress 10 kg. per square millimeter. The problem of determining fatigue strength in actual (nonsymmetrical) conditions, the stress-concentrating

effect of the gullets, and the necessary strength safety-margin are discussed.

Vinogradov. 1966. (Jointing, Planing, Molding, and Shaping)

TEMPERATURE

Feihl and Godin. 1967. (Veneer Cutting)

Gill, G. S. 1965. TEMPERATURE AND STRESS DISTRIBUTION IN A ROTATING CIRCULAR SAW. M.S. Thesis. Univ. Calif. Berkeley.
Temperature distribution in a circular rotating saw blade heated at the periphery was measured experimentally for various speeds of rotation and for different clamping radii. The heat transfer from the rotating blade was reviewed, and a modified theoretical expression based on turbulent air flow at the blade surface, was established. This closely represented the measured temperature distribution. The temperature function so obtained was used to calculate the thermal stresses. The importance of eliminating or reducing compressive thermal stresses by the use of tensioning was indicated theoretically and illustrated graphically. A qualitative approach to optimum vibrational stability of the blade was also proposed.

Glijer, L. 1967. EFFECT OF CERTAIN FACTORS ON THE HEATING OF CIRCULAR SAWS DURING WORK. Zesz. Nauk. Szkol. Gospod. Wiejsk. 1: 45-60. Warsaw.

Glijer, L. 1967. HEATING OF CIRCULAR SAWS DURING WORK. Przem. Drzewny 18(5): 12-15.

Stanislao, J., Baudisch. H. D., and Richman, M. G. 1967. TEMPERATURE CONTROL IN MACHINING. Instrum. and Contr. Syst. 40(8): 101-103.
Describes an instrumentation technique employing a direct thermoelectric method to continuously detect the maximum temperature on the tool-chip interface. Temperatures to 500° C. were measured with an accuracy of ±20° C.

Sugihara. 1965. (Properties of the Cutting Edge and Cutter; Stability)

FRICTION

Cuprin. 1966. (Properties of the Cutting Edge and Cutter; Dulling)

McKenzie, W. M. 1967. FRICTION IN WOOD CUTTING. Forest Prod. J. 17(11): 38-43.
The friction coefficients of a large number of species of world-wide origin were investigated. The coefficient of friction between tool and chip is important because a change in friction angle is equivalent to an equal and opposite change in rake angle. Friction angle decreases as the coefficient decreases. When rubbing wood against solvent-cleaned stainless steel the following factors had little effect on coefficient of friction: (1) manner of drying, (2) surface roughness of the wood, (3) temperature up to 100° C., (4) pressure up to 200 p.s.i., (5) grain direction, (6) species, except for a few noticeably greasy woods such as lignum vitae and tallow wood (Eucalyptus microcorys). *Although there was little interspecies variation observed, the author concludes that under some conditions, species variation may be critical. Several factors affected coefficient of friction: (1) moisture content: Effect depends on cutting speed, i. e., at very low speeds the coefficient will be slightly higher for wet than for dry wood whereas at normal speeds the friction coefficient will be lower for wet than dry wood. (2) tool roughness: At cutting speeds below 55 mm. per second, smooth tools had a lower coefficient but at higher speeds there was practically no effect with either wet or dry wood. The author concludes that for practical purposes improved tool finish does not reduce friction coefficient. (3) cutting speed: For normal dry wood the coefficient decreases from about 0.55 at 0.05 mm. per second to 0.40 at 4,000 mm. per second (800 f.p.m.). For green wood the coefficient decreases from 0.6 at 0.2 mm. per second to 0.15 at 4,000 mm. per second. The author considers it a reasonable assumption that cutting force is proportional to chip thickness when cutting with an ideally sharp tool and that the added cutting force due to bluntness approaches a constant as chip thickness increases. Variation in friction coefficients of a partially severed chip against the workpiece needs more study.*

RESEARCH INSTRUMENTATION AND TECHNIQUES

Anonymous. 1967. NEW SAW BLADE TESTING DEVICE. Timber Trades J. 263(4754): 65-66.
Describes an electronic saw-blade tester, recently introduced by Otto Jörg, Metallwaren, Oberstaufen/Weissach 13, Germany, which automatically measures and records lateral deviations of a bandsaw blade during actual cutting.

Abeels. 1966. (Sawing; General)

Duchnowski. 1966. (Sawing; Sash Gangsawing)

Dunmire and Englerth. 1967. (Machinability of Lumber and Particleboard)

Erickson, J. R. 1967. OPERATIONAL AMPLIFIER, A USEFUL TOOL FOR FORESTRY RESEARCH. Forest Prod. J. 17(3): 42-44.
Describes the use of instruments which can perform mathematical operations (e. g., integration and differentiation) on electrical signals. The signals are proportional to the physical energy required for cross-cut shearing of various woods and for chipping hardwoods. Cost of the equipment was about $200. Data-processing time was reduced by use of the equipment.

Fengel. 1967. (Orthogonal Cutting)

Heebink, B. G. 1967. MEASURING SURFACE IRREGULARITIES IN PANEL PRODUCTS. U. S. Dep. Agr. Forest Serv. Res. Note FPL-0159, 2 pp. Forest Prod. Lab., Madison, Wis.

Julich. 1965. (Sawing; Chain Sawing)

Kulesov, L. F., and Suin, V. E. 1966. AN INDUCTION 'PROFILOGRAPH' FOR MEASURING UNEVENNESSES ON WOOD. Derev. Prom. 15(2): 10-11.
Describes the design and use of a new Soviet instrument.

Pahlitzsch, G., and Dziobek, K. 1965. THE EVALUATION OF MACHINED WOOD SURFACES. PART II. Holztechnologie 6(4): 219-224. (Translated by Joint Pub. Res. Serv., U. S. Dep. Com., Wash., D. C. FPL-668. 1966.)
Describes a method for determining roughness by means of a roughness integrator (profilograph) in connection with a classifier which permits evaluation from many viewpoints. The Abbot curve, a cumulative frequency curve of roughness (the profile ordinates), is of particular significance.

Schmutzler, W. 1966. CENTRIFUGAL-FORCE TESTING OF TOOLS WITH ULTRA-HIGH REVOLUTION SPEEDS. Holz als Roh- und Werkstoff 24(8): 338-340.
Describes a machine for testing high-speed tools with cen-

trifugal force. It was built from an ultracentrifuge having a rotor speed of 90,000 r.p.m. The axis of the machine is autocentering. A vacuum in the test chamber abates noise and heat. The machine detects unbalanced tools and loose or defective parts.

Sieminski, R. 1966. TESTING AND MEASURING THE SURFACE STRUCTURE OF WOOD AND WOOD-BASE MATERIALS. Holz als Roh- und Werkstoff 24(9): 396-404.
Wood and wood-based material were machined using 19 different methods of sanding, sawing, boring, planing, etc., and mean roughness of each surface determined. Surfaces were graded into classes according to mean roughness. Generally, roughness measured across the grain was greater than that measured parallel to the grain. Exceptions to this generalization were frame- and bandsawn surfaces where roughness in the fiber direction was usually greater. Geometric surface structures of wood and wood-based materials were influenced by fiber direction, state of tools and machine, and cutting conditions. Irregular grain caused checks and splitting. Blunt cutters squeezed off or plucked out fibers. Waviness was caused by oscillation of tools, clearance in bearings, and irregular feed. Unevenness was reduced by correct choice of knife edge, appropriate setting of chip thickness, and optimum cutting-velocity.

Stanislao, Baudisch, and Richman. 1967. (Properties of the Cutting Edge and Cutter; Temperature)

Thunell, B., and Aoyama, T. 1966. MICROSCOPIC OBSERVATIONS ON THE MACHINED SURFACE OF WOOD. Mikroskopie 21(7/8): 189-196.
Under a light microscope the cells on sawn surfaces were found to be crushed and severely deformed. When planer, handplane and sander were used, the cut surfaces were smooth and cell damage was minor.

Thunell, B., and Wallin, G. 1966. MEASUREMENT OF CUTTING FORCES IN FRAME SAWS. Paperi ja Puu 48(11): 683-695.
Discusses the various forces, and describes methods of measurement. Equipment includes gauges, filters, detecting sensors, and recording meters. A method is developed to give more accurate and reproducible results, by ensuring the control of conditions during measurement.

NOMENCLATURE

McKenzie, W. M., and Bolza, E. 1965. UNIFORM TERMINLOLGY FOR IMPORTANT WOOD CUTTING OPERATIONS: IN ENGLISH, GERMAN, FRENCH AND SPANISH. AMENDED PROPOSALS. *In* IUFRO Proc. 1965, Vol. 3, Sect. 41, 20 pp. Melbourne.
Proposes (with diagrams) standardized terms and symbols for cutting geometry, wood orientation, basic cutting situations, rotary cutterheads, veneer cutting, and saws.

Thunell, B. 1966. DIMENSIONAL ACCURACY IN THE SAWING OF ROUNDWOOD. Holz als Roh- und Werkstoff 24(12): 598-602.
Discusses terms and definitions (nominal sawn dimension, shrinkage allowance, tolerance, etc.), the need for international standardization in this field, and the effect of saws and sawing conditions or dimensional accuracy.

Wuster, E. 1966. A LANGUAGE-INDEPENDENT SYMBOLISM FOR THE DESIGNATION OF SAW TEETH. Holztechnologie 7(4): 233-235.
An ISO-Recommendation about the symbolic designation of tooth profiles of woodcutting saw blades is going to be accepted. This ISO-Recommendation is based upon the suggestions made several decades ago by the author, who proposes a symbolic designation system for indicating the set and sharpening of saw teeth. The system is independent of language.

MACHINABILITY OF LUMBER AND PARTICLEBOARD

Anonymous. 1966. (Barking) Birch.

Anonymous. 1967. (Properties of the Cutting Edge and Cutter; Dulling) Paper.

Anonymous. 1967. (Veneer Cutting) Sitka spruce.

Anonymous. 1967. VENEER CUTTING AND DRYING PROPERTIES OF TANOAK. U. S. Dep. Agr. Forest Serv. Res. Note FPL-0164, 8 pp. Forest Prod. Lab., Madison, Wis.

Anonymous. 1967. VENEER CUTTING AND DRYING PROPERTIES OF WESTERN LARCH. U. S. Dep. Agr. Forest Serv. Res. Note FPL-0163, 4 pp. Forest Prod. Lab., Madison, Wis.

Abeels. 1966. (Sawing; Bandsawing) Spruce.

Abeels. 1967. (Sawing; General) Spruce and beech.

Ainslie. 1965. (Veneer Cutting) Douglas-fir and hemlock.

Bocanet. 1965. (Barking) Beech.

Carruthers. 1967. (Jointing, Planing, Molding, and Shaping) Hardwoods.

Dumitrescu-girbovi. 1965. (Sawing; Sash Gangsawing) Beech.

Dunmire, D. E., and Englerth, G. H. 1967. DEVELOPMENT OF A COMPUTER METHOD FOR PREDICTING LUMBER CUTTING YIELDS. U. S. Dep. Agr. Forest Serv. Res. Pap. NC-15, 7 pp. North Cent. Forest Exp. Sta., St. Paul, Minn.
A system of locating defects in a board by intersecting coordinate points was developed and a computer program devised that used these points to locate all possible clear areas in the board. The computer determined the yields by placing any given size or sizes of cuttings in these clear areas, and furthermore stated the type, location, and number of saw cuts. The computer improved on the manual act of extracting cuttings from a board. This was demonstrated conclusively in the yields obtained from a representative sample of 4/4 hard maple lumber in the FAS, Select, and No. 1 Common lumber grades. Thus, a plant manager can obtain an accurate estimate of cutting yields from any grade of hard maple lumber.

Englerth, G. H. 1966. MACHINING AND OTHER PROPERTIES OF FAST- VERSUS SLOW-GROWN TREES. *In* BLACK WALNUT CULTURE, pp. 77-82. U. S. Dep. Agr. Forest Serv. N. Cent. Forest Exp. Sta., St. Paul, Minn. Pap. presented at Walnut Workshop, Carbondale, Ill.
Machining and toughness tests were made on wood from slow-, moderate-, and fast-grown black walnut trees. Wood from fast-grown trees was equal or superior in planing,

shaping, and turning qualities to wood from slow-grown trees. Fast-grown material had higher specific gravity, slightly darker heartwood color, wider zone of sapwood, and was tougher than slow-grown material. No veneering tests were made on wood from the fast-grown trees, but slicing tests showed that the moderate-growth wood sliced as well as slow growth wood.

Feihl, O., and Godin, V. 1965. PLANTATION-GROWN RED PINE FOR VENEER AND PLYWOOD. Can. Wood Prod. Ind. 65 (1B): 28-32.
Fifty-year-old red pine logs averaging 12 inches in diameter were peeled without difficulty at room temperature into veneer ranging from 1/16- to 1/6-inch thick. Optimum lathe settings were as follows:

	Veneer thickness, inch				
	1/16	1/10	1/8	1/7	1/6
Thickness set, inch	0.062	0.100	0.124	0.144	0.166
Horizontal opening of nosebar, inch	0.050	0.084	0.104	0.124	0.146
Vertical opening of nosebar, inch	0.010	0.015	0.020	0.025	0.030
Knife angle for a log diameter of 24"	90°	90°	90°	90°	90°
Knife angle for a log diameter of 9"	89°	89°	89°	89°	89°
Practical cutting temperature, °F.	60	60	60	60	60

The knife had a main bevel of 20° with a 0.02-inch-wide microbevel to 30° sharpness angle. It had a concave grind with 0.001-inch concavity. The nosebar face made a 14° angle with the vertical. To prevent bending of the bolt during cutting, a back pressure roll should be used. Veneer recovery from the 12 test logs was 69-percent of log volume. Depending on the height and time of pruning, the amount of clear veneer varied from 20 to 58 percent of the total volume of veneer produced. The veneer was dried and glued into plywood without difficulty.

Fukui, Hara, and Sato. 1965. (Sawing; Circular Sawing) Plywood.

Galinkin and Associates. 1965. (Turning) Compressed wood.

Hallock. 1966. (Sawing; General) Southern pine.

Herrick and Christensen. 1967. (Chipping, Flaking, and Grinding; Chipping) Hardwoods.

Hoshi, T. 1966. THE PROPERTIES OF IMPORTANT JAPANESE WOODS: CUTTING PROPERTIES OF THE WOODS GROWN IN CHUGOKU, SHIKOKU AND TOHOKU DISTRICTS. Government Forest Exp. Sta. Bull. 189, pp. 161-182. Tokyo.
Contains graphs showing the combinations of cutting force and feed speed that gave the best surface quality for 13 species when other factors (cutting and knife angle, speed of cutterhead, etc.) remained constant. Also contains graphs and a table showing suitable cutting conditions for Fagus crenata, Quercus crispula, *and* Pinus densiflora.

Iliev, T., Filipov, G., and Sehtov, H. 1967. INVESTIGATIONS ON THE CUTTING OF BEECH PARTICLEBOARDS WITH CIRCULAR SAWS. Nauch. Tr. Lesoteh. Inst., 14, pp. 133-146.
Determines the effect of board density, feed speed and saw wear on specific work in cutting; develops nomograms for determination of suitable cutting schedules.

Jain, Gupta, Shah, and Tandon. 1966. (Veneer Cutting) Indian species.

Jain and Rowat. 1966. (Jointing, Planing, Molding, and Shaping) Indian species.

Jakunin. 1960. (Sawing; Circular Sawing) Hardwoods.

Jones. 1966. (Sawing; Circular Sawing) *Pinus radiata.*

Jones. 1966. (Sawing; Circular Sawing) Plywood.

Koch. 1966 and 1967. (Sawing; General) Southern pine.

Krisztian. 1966. (Veneer Cutting) Walnut and mahogany.

Lejhtling and Smorgon. 1966. (Sawing; Sash Gangsawing) Larch.

Leney and Moir. 1967. (Veneer Cutting) Douglas-fir and hemlock.

Ljubimov. 1966. (Machining with Coated Abrasives) Birch plywood.

Lutz. 1967. (Veneer Cutting) Southern pine.

Lutz, Duncan, and Scheffer. 1966. (Veneer Cutting) Southern pine.

Lutz and Patzer. 1966. (Veneer Cutting) Southern pine and yellow-poplar.

Malcolm. 1967. (Sawing; Circular Sawing) Red oak.

Meriluoto. 1967. (Veneer Cutting) Birch.

Mette and Kommert. 1964. (Defibrating) Spruce.

Nakamura. 1966. (Machining with Coated Abrasives) Plywood.

Nakamura and Ohira. 1963. (Barking) Japanese species.

Nearn. 1965. (Veneer Cutting) Douglas-fir.

Olszewski. 1965. (Properties of the Cutting Edge and Cutter; Tool Material) Particleboard.

Olszewski, J. 1967. TRIAL IN THE USE OF CERAMICS FOR THE TEETH OF CIRCULAR SAWS FOR CUTTING PARTICLE BOARDS. Zesz. Nauk. Szkol. Gospod. Wiejsk. (1): 71-94. Warsaw.

Pahlitzsch, G., and Jostmeier, H. 1966. INVESTIGATIONS DURING THE MACHINING OF PARTICLEBOARD. Moderne Holzverarbeitung 1(3): 186-195; (4): 230-235; (5): 310-317; (6): 382-388; (7): 456-460.
The work is divided into five parts: (1) Experimental equipment and procedures. (2) influence of cutting speed on cutting force. Cutting power when machining particleboard was least at a knife velocity of 40 m. per second (7,800 f.p.m.). Cutting power declined insignificantly as knife velocity was increased from slow speed to 40 m. per second, but then increased considerably as knife velocity was increased. Cutting power increased with increasing board density. In particleboard, as contrasted with natural wood, no big difference in cutting power was observed between up-milling and down-milling. (3) Influence of different cutting conditions on cutting force. With pine, poplar and beech particleboard, cutting force increased with increased feed per tooth and with increased chip thickness. Cutting force increased with increasing depth of cut and with decreasing rake angle. Because of the greater density of the top and bottom layers of chipboard, these layers required one and one half to twice as much cutting force as the less-dense middle layer. Some layered boards were examined that had chipboard cores; the dense top and bottom layer board required from four to six times as much cutting power as the core. (4) Influence of different board materials. Tool wear was proportional to specific gravity of the board. Chips that contained dirt or silicates caused more wear than boards made of clean chips. Tool wear was proportional to the amount of resin in the board, whereas wood species was relatively unimportant. No difference in rate of tool wear was observable between up- and down-milling. (5) Tool working life as related to tool material. For a cutting depth of 3 mm. or more, the length of path that the knife was in the cut was decisive in determining allowable operating time for the knife. The hardest metal types (e. g.,

K01 and K10) gave longer operating times without dulling than the tougher metals (e. g., the K-group used for chipper knives) provided the edges had been sharpened carefully. In general, operating time for metal knives was proportional to knife hardness. Oxide-ceramic cutting edges gave about the same operating time as attained with hard metals of the chipping-usage group K20 to K10. Therefore, oxide-ceramic cutting edges do not yet seem practical for milling of wood or layered boards.

Pahlitzsch and Jostmeier. 1966. (Properties of the Cutting Edge and Cutter; Dulling) Particleboard.

Pahnutova, L. V. 1966. TYPES AND PRODUCTIVITY OF EQUIPMENT FOR TRIMMING PANELS TO SIZE. Les. Zh. 9(6): 87-92.
Classifies 27 U. S., European, and Soviet machines into four basic types, and makes a detailed mathematical analysis of the productivity of each type and each machine.

Peters, C., and Lutz, J. F. 1966. SOME MACHINING PROPERTIES OF TWO WOOD SPECIES GROWN IN HAWAII, MOLUCCA ALBIZZIA AND NEPAL ALDER. U. S. Dep. Agr. Forest Serv. Res. Note FPL-0117, 10 pp. Forest Prod. Lab., Madison, Wis.
Planed molucca albizzia was 56 percent free of undesirable characteristics; shaped, 91 percent was of good to excellent quality; turned, 69 percent fair to excellent; bored, 100 percent good to excellent; and mortised, 89 percent fair to excellent. For nepal alder results were 58 percent, 54 percent, 86 percent and 27 percent, respectively. Based on machining properties, both species should be suitable for core stock if sufficient straight grain material is available. Nepal alder could be used for medium-value furniture parts. Molucca albizzia is too soft for use in exposed furniture parts.

Porter. 1966. (Sawing; Sash Gangsawing) *Pinus radiata.*

Rietz and Jensen. 1966. (Jointing, Planing, Molding, and Shaping) Oak.

Scheibeler. 1966. (Sawing; General) Pulp and board.

Schmutzler. 1966. (Machining with Coated Abrasives) Particleboard.

Seto and Nozaki. 1966. (Machining with Coated Abrasives) Plywood.

Siapno. 1963. (Veneer Cutting) Tangile and red lauan.

Stewart. 1967. (Orthogonal Cutting) White ash.

Zajcev and Smolin. 1967. (Properties of the Cutting Edge and Cutter; Dulling) Particleboard.

BIBLIOGRAPHIES

Koch, P., and McMillin, C. W. 1966. WOOD MACHINING REVIEW, 1963 THROUGH 1965. Forest Prod. J. Part 1, 16(9): 76-115; Part 2, 16(10): 43-48.
Contains abstracts of 198 references arranged by subject-matter categories. Has bibliography of prior reviews of wood-machining literature beginning in 1957.

Powell, Stephen, Graham, *et al.* 1967. (Machining with Coated Abrasives)

Wacker. 1967. (Jointing, Planing, Molding, and Shaping)

REPORTS OF RESEARCH PROGRAMS AND INDUSTRIAL DEVELOPMENTS

Anonymous. 1965. TIMBER UTILIZATION. FUNDAMENTAL CUTTING RESEARCH. Annu. Rep. CSIRO 1964-65, pp. 52-54. Melbourne.

Anonymous. 1967. FURNITURE PRODUCERS SIZE UP THEIR MACHINERY NEEDS. Wood and Wood Prod. 72(4): 24-25, 69, 70.
Trends in the furniture industry are towards upgraded styles, more complicated finishes, lower quality of wood, and higher labor and material costs. These trends require more intricate machining and smoother wood surfaces; careful utilization of basic raw materials to maximize yields and reduce costs; and a reduction of labor and highly skilled operators. The report of the Machinery Study Committee of the Southern Furniture Manufacturers Association is summarized. Specific comments and recommendations on the improvement of various types of machines, tools and tool steel, lumber drying, handling and receiving lumber, as well as clamping and gluing are cited.

Carruthers. 1967. (Sawing; General)

Dickinson, F. 1967. RECENT DEVELOPMENTS IN THE UNITED STATES IN THE MANUFACTURING PROCESSES FOR LUMBER AND VENEER. Holz als Roh- und Werkstoff 25(2): 68-75.
West Coast industry is developing methods to produce a large volume of products from new-growth timber. Effort is being directed towards the initial breakdown of logs into boards and cants. In both the West and South, the log gang frame saw is being used. Multiple band and circular saw units and the use of a combination of saws and chip-producing knives in the same machine to produce both lumber and pulp chips are receiving much attention. Developments and adaptations in machinery used after the initial breakdown are double-arbor edgers; increased use of memory systems, especially in lumber trimming and segregation operations; and complex shadow line systems to incease efficiency of lumber edging and cutting shop grades of lumber into dimension stock. Production of chips for pulpwood and particleboard from sawmill residue has increased. The softwood veneer and plywood industry is becoming a small-log industry with equipment developments and adaptations including high-speed lathes with oscillating knives and rapid lathe loaders. An automated green veneer clipper system which scans the moving sheet of veneer for defects, makes decisions, and activates the clipper promises to reduce costs in the production of softwood veneer.

Endersby, H. J. 1966. CUTTING ACTION OF WOODWORKING TOOLS. Timber Trades J. 256(4663): 53, 55.
Reviews studies made in the past 37 years by the Forest Products Research Laboratory (United Kingdom) in the area of mechanics of woodcutting proceses.

Jirku, F. 1965. NEW TRENDS IN PROCESSING WOOD IN SAWMILLS. Holztechnologie 6(4): 269-272.

Koch. 1967. (Chipping, Flaking, and Grinding; Chipping Headrigs and Edgers)

Koch. 1967. (History and General Texts)

Lutz. 1967. (Veneer Cutting)

Malcolm, F. B. 1965. WHAT HAS RESEARCH DONE FOR THE SAWMILL? Northern Logger (14): 3, 16-17, 36, 39.

Briefly discusses the development of the saw to the present time, experimental concepts of cutting, improvements in auxiliary equipment, and recent developments in sawing and lumber drying methods.

Pahlitzsch. 1966. (Jointing, Planing, Molding, and Shaping)

PATENTS

Bartos, L. 1964. CLAMPING AND DRIVING DEVICE FOR ROTATING LOGS ON WOOD PEELING MACHINES. Deut. Patentamt. Auslegeschrift, Bundesrepublik Deut. No. 1,164,636. 1964. (Also Can. Forest Prod. Lab. Transl. 193.)
Describes a retractable chuck with an inner driver equipped with a centering point, and an outer driver of larger diameter that can be moved axially out of the clamping position while the clamped log is rotating. Retraction of the outer driver is controlled by the position of the knife holder.

Collins, E. H. 1965. METHOD OF AND APPARATUS FOR KERFLESS CUTTING OF WOOD. U. S. Patent No. 3,327,747. U. S. Pat. Office. Granted June 27, 1967.
Describes several apparatuses to longitudinally slice thick pieces of wood with a vibrating heated knife, scoring knives in series, and scissor-acting knives. Patent assigned to Weyerhaeuser Company, Tacoma, Washington.

Hallock, H. 1966. SAW BLADE FOR CUTTING LOGS. U. S. Patent 3,229,736. U. S. Pat. Office. Granted January 18, 1966.

Johnson, D. L. 1959. METHOD AND MEANS FOR CUTTING A FLAT SURFACE ON WOOD BY PRODUCING WOOD FLAKES FROM THE MATERIAL AS REMOVED. U. S. Patent No. 2,889,859. U. S. Pat. Office. Granted June 9, 1959.
Describes an end-milling cutterhead for a chipping headrig. The cutterhead is designed to cut flakes. Cutting action is primarily in the veneer (0-90) direction. The head illustrated carries fifty-nine 2-inch-long, straight knives that are helically disposed on the face of a large disk. The disk is not flat but might be described as having a face with conical spiral. The inventor describes the location of the series of knives as "radially retreating while axially advancing toward the work."

Pease, L. 1967. SIDE CHIPPERS AND EDGER SAWS. U. S. Patent No. 3,323,565. U. S. Pat. Office. Granted June 6, 1967.
The patent describes invention of a chipping-edger designed to reduce a slab into square-edged lumber plus pulp chips. The edger may incorporate a top chipping-head as well as two side chipping-heads and intermediate ripsaws.

Pease, L. 1967. SMALL LOG PLANT. U. S. Patent No. 3,304,971, U. S. Pat. Office. Granted February 21, 1967.
The patent covers the basic "Beaver" chipping headrig designed to remove pulp chips from a small log to make a cant. The cant is subsequently reduced to lumber by passing it through a cluster of saws.

Pease, L. 1967. TWO SIDE, TOP AND BOTTOM CHIPPERS IN SERIES. U. S. Patent No. 3,326,252. U. S. Pat. Office. Granted June 20, 1967.
The patent describes invention of a peripheral milling (planing-type) chipping-headrig designed to convert logs directly into posts or poles hexagonal in cross section. Excess wood is removed in the form of pulp chips.

Williamson, J. S. 1965. METHOD OF PRODUCING VENEER. U. S. Patent No. 3,205,111. U. S. Pat. Office. Granted September 7, 1965.

SAFETY, INCLUDING NOISE

Anonymous. 1967. NOISE AND WOODWORKING MACHINERY. Timber Res. and Develop. Assoc. Adv. Serv. Leafl. 19, 11 pp. London.
Author states that planers and molders can give noise levels of 100 to 110 decibels when softwoods are fed at speeds over 100 f.p.m. or when hardwoods are fed at lower speeds. On softwoods, 110 decibels will not be exceeded at feed speeds below 200 f.p.m. The noise from planers and molders is principally (i. e., peaks) in the range from 1 to 2 kc. per second. Prolonged exposure to 95 decibels in this frequency range causes some damage to hearing; immediate pain and partial or complete deafness results from even short-term exposure to a noise level of 130 to 140 decibels. Protective measures are discussed. The two types of enclosure described reduce noise by 40 and 25 decibels respectively; their constructional specifications comply with the British Factory Acts. An appendix includes definitions of noise, sound, audible frequencies, frequency, wavelength, tones, loudness, sound meters, sound level, decibel, octave bands, octave-band filters, phons and sones, and additiveness of sounds.

Bygren, K. G., Floren, J. E., and Lidberg, P. 1966. NOISE AND VIBRATION IN POWER SAWS. Tekn. ForsknStift. Skogsarb. 2, 4 pp. Stockholm.
Discusses methods of measurement and harmful effects of noise. Gives results of Swedish studies.

Clippert, G. H. 1965. A STUDY ON THE PROBLEM OF CHAINSAW NOISE. Amer. Pulpwood Assoc. Tech. Pap. 65-31: 19-20.

Grin'kov, V. P. 1967. THE CAUSES OF NOISE IN THE WORK OF CIRCULAR SAWS. Derev. Prom. 16(1): 9-10.

Kato, S., and Ohsato, S. 1965. AN EXPERIMENTAL STUDY ON THE NOISE OF CHAIN SAWS. Tokyo Univ. For. Bull. 60, pp. 113-124.
Measurements made on three chain saws (McCulloch-BP-1, McCulloch-740, and Homelite-ZIP) showed that the noise of the engine, measured at the rim of the operator's helmet, was greater than 110 decibels. In field operations, the added mechanical sound produced by the chain chipping wood could bring the total up to 120 decibels.

Popescu, P., Teodorescu, C., and Senchea, A. 1966. DETERMINATION OF CARBON OXIDE IN THE DISCHARGE GASES OF POWER SAWS AND CABLE CARS. Rev. Padurilor 81(11): 645-647.

Schmutzler, W. 1967. NOISE ABATEMENT IN WOODWORKING. Holz als Roh- und Werkstoff 25(4): 130-134.

On machines with cutterblocks, sound intensity rises with the fourth power of the cutterblock speed. Addition of 10 equally noisy sound sources increases the total sound level 10 decibels. The main object in noise abatement is to eliminate the noise source by constructive changes of tool, surrounding table, and pressure lips. Extension of noises is inhibited by sound attenuation through air and solids as well as sound damping.

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longleaf pine:

an annotated bibliography, 1946 through 1967

Thomas C. Croker, Jr.

UTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director

FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

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Longleaf Pine: An Annotated Bibliography, 1946 Through 1967

Thomas C. Croker, Jr.

When W. G. Wahlenberg published *Longleaf Pine* in 1946, he included a complete list of the American literature on this important southern tree. The monograph stands as one of the major references of forestry literature, and its bibliography has saved untold hours for students and researchers.

In the 2 decades just past, *Pinus palustris* Mill. has been the subject of much research and observation, and the resulting publications have significantly advanced our knowledge of the species. It is the purpose of this annotated bibliography to give the reader a convenient summary of the literature accretions since Wahlenberg published.

The paper records all known publications from 1946 through 1967. It also includes some 1944 and 1945 titles that appeared after Wahlenberg's volume went to press. Popular as well as scientific articles are included.

Forestry Abstracts, published by the Commonwealth Agricultural Bureaux, Farnham Royal, England, was a chief source of references. The Bureaux' Catalog of World Forestry Literature on Microfilm and its Card Title Service were invaluable supplements to the *Abstracts.* The search also included the USDA *Bibliography of Agriculture,* the Dictionary Catalogue of the Yale Forestry Library, annual reports of the Southern and Southeastern Forest Experiment Stations, and a card file of references maintained by the author since 1946. No literature search can be completely successful when the subject is as broad as longleaf pine. There probably are important omissions, and notification of these would be appreciated.

Citations are arranged by the Oxford decimal system. The table of contents provides a key to the classifications, and further information is available in *The Oxford System of Decimal Classification for Forestry,* published by the Commonwealth Agricultural Bureaux. Each publication is listed only once, under the subject code that appeared most appropriate. Classification was often difficult, and the reader is urged to scan related subject heads as well as the one in which his primary interest lies. For some users, the index of authors may partly compensate the lack of cross referencing.

The bibliography is completely annotated. Many of the abstracts are reprinted from *Forestry Abstracts,* with the generous permission of the Commonwealth Forestry Bureaux. These are identified with the legend FA. Authors' summaries or abstracts of their own publications were another common source, as were briefs appearing in the publications lists of the Southern and Southeastern Forest Experiment Stations. Many of the abstracts were written by the author after a reading of the original publication.

For what the bibliography contains or omits, the author alone is responsible. This being understood, he gratefully acknowledges the decisive assistance of Patricia J. Bridges, Orahlee F. Villoldo, and Patricia E. Armatis of the Southern Forest Experiment Station's Library. Without their help, the literature search would have been an impossible task. And he thanks Elaine P. McGowan of the Station's editorial staff for remorselessly combing his citations into some degree of typographical consistency.

1. FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS, CLIMATE, SITUATION, SOIL

Dixon, J. B., and Wear, J. I. 1964. X-RAY SPECTROGRAPHIC ANALYSIS OF ZINC, MANGANESE, IRON, AND COPPER IN PLANT TISSUE. Soil Sci. Soc. Amer. Proc. 28: 744-746.
Describes trial analyses of Pinus taeda, P. palustris, P. echinata, *and* P. elliottii, *among others. Results show that the method is satisfactory for determining Zn, Mn, and Fe (but not Cu) in pine needles. FA*

15 ANIMAL ECOLOGY. GAME MANAGEMENT

Goodrum, P. D., and Reid, V. H. 1959. DEER BROWSING IN THE LONGLEAF PINE BELT. Soc. Amer. Forest. Proc. 1958: 139-143.
Approximately 78 woody species of browse plants are available to white-tailed deer in the longleaf pine forests. Half of these are starvation forage, 17 percent are highly preferred, and 33 percent are intermediate. Prescribed burning is beneficial to deer. Longleaf pine habitat usually will not support more than one deer for 26 acres, but carrying capacity varies considerably. Usually there is no shortage of forage in the spring.

Lay, D. W. 1957. BROWSE QUALITY AND THE EFFECTS OF PRESCRIBED BURNING IN SOUTHERN PINE FORESTS. J. Forest. 55: 342-347.
In the Siecke State Forest, Texas, samples of 28 species of deer forage were collected in 1954 and 1955 from a longleaf pine stand on sites that had been subjected to one, two, or three prescribed burns and from adjacent unburned areas. Ten of the species were sampled for the four seasons. Analyses of the nutrient content of the tips at 15 percent moisture content are tabulated. Burning increased protein content by as much as 42.8 percent and P_2O_5 *by 77.8 percent, but these effects disappeared after ca. 2 years. FA*

Lay, D. W. 1967. BROWSE PALATABILITY AND THE EFFECTS OF PRESCRIBED BURNING IN SOUTHERN PINE FORESTS. J. Forest. 65: 826-828.
Gives details of the effects of burning nearly half of a 58-acre deer-pen (in a Pinus palustris *stand and containing four white-tailed deer) on the production and utilization of browse, in comparison with an unburned area. The results indicated that the production of browse on the burned area increased significantly (from 264 pounds per acre to 332 pounds after 2 years) and utilization on the burned area was more than double that on the unburned area. FA*

Meanley, B. 1966. RED-WINGED BLACKBIRDS SEARCHING BENEATH PINE BARK FOR INSECTS IN WINTER. Auk 83: 480-481.
Over a 5-year period, always in winter, red-winged blackbirds (Agelaius phoeniceus) *have been observed feeding on insects beneath the bark of longleaf pine in east-central Alabama.*

Moore, W. T. 1967. DEER BROWSE RESOURCES OF THE ATOMIC ENERGY COMMISSION'S SAVANNAH RIVER PROJECT AREA. U. S. Dep. Agr. Forest Serv. Resource Bull. SE-6, 28 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Browse plants in the South Carolina sandhills are listed by preference classes for a number of overstory timber classes including pine plantations and natural stands of longleaf pine and longleaf-scrub oak

Reid, V. H., and Goodrum, P. D. 1960. BOBWHITE QUAIL A PRODUCT OF LONGLEAF PINE FORESTS. *In* Trans. 25th N Amer. Wildlife Conf., pp. 241-252.
In this forest quail study in southwestern Louisiana, marked fluctuations in annual production and populations were recorded. The better winter bobwhite populations were significantly related to high reproductive success the preceding nesting season. The population trend was much the same on hunted and unhunted longleaf pine range, and the percentage of young birds found on an area protected from hunting for 14 years closely approximated that for the surrounding annually hunted area. One of the best reproductive seasons had a good late quail hatch. Significant relationships were found between annual production and temperature and between annual production and precipitation records for the preceding summer months. In general the best quail crops followed cool, moist summers while poorest reproductive success followed hot, dry summers. Temperature and precipitation readings during the warm month period may be useful criteria for predicting annual quail production and winter populations in this area. FA

Ripley, T. H., Wilhite, L. P., Downing, R. L., and Harlow R. F. 1965. GAME FOOD PLANTS IN SLASH-LONGLEAF FLAT WOODS. *In* Sixteenth Annu. Conf. Southeast. Assoc. Game and Fish Comm. Proc. 1962: 35-44.
Wiregrass and palmetto understory types were superior to the gallberry types for quail and turkey.

Stransky, J. J. 1968. TIMBER AND QUAIL—DUAL FOREST CROPS. Proc., 1967 Annu. Meeting, Tex. Chapter, Soc. Amer. Forest., pp. 1-5.
Quail management is compatible with timber management and other important uses of the longleaf-slash pine forests. Hunting and management practices are described.

Stransky, J. J., and Halls, L. K. 1967. TIMBER AND GAME FOOD RELATIONS IN PINE-HARDWOOD FORESTS OF THE SOUTHERN UNITED STATES. *In* Fourteenth Congr. Proc., Int. Union Forest. Res. Organ. Vol. 7: 208-217.
Discusses the maintenance of favorable game habitats and suggests various silvicultural ways of improving game food supplies in intensively managed forest. FA

16 GENERAL BOTANY

Allen, R. M. 1958. A STUDY OF THE FACTORS AFFECTING HEIGHT GROWTH OF LONGLEAF PINE SEEDLINGS. Diss. Abstr. 19: 620.
The study was limited almost entirely to very young seedlings. Measurements of photosynthesis and respiration showed that longleaf pine seedlings have a lower rate per unit needle-weight than either slash or loblolly pine seedlings, both of which, unlike longleaf, make normal epicotyl elongation very early. Slash and loblolly pine epicotyls showed no major differences in the metabolites resulting from incubating the epicotyls in labeled glucose or succinic acid. Longleaf epicotyls were found to contain a much larger quantity of free amino acids than the other two species, although qualitatively there was little difference between the species at any of the development stages studied. Neither cold treatment nor change in day-length increased the growth of longleaf seedlings, but two of the growth regulators studied, gibberellic triiodobenzoic acids caused a small but consistent increase in epicotyl length. Paper-chromatographic studies of the ether-soluble acidic

substances in seedling epicotyls and sapling buds showed at least four growth-promoting and one growth-inhibiting substances to be present in pine; one of the growth-promoting substances was absent from extracts of nonelongating longleaf pine epicotyls. FA

Allen, R. M. 1960. CHANGES IN ACID GROWTH SUBSTANCES IN TERMINAL BUDS OF LONGLEAF PINE SAPLINGS DURING THE BREAKING OF WINTER DORMANCY. Physiol. Plant. 13: 555-558.
The greatest changes in ether-soluble acid growth-substances were an increase in the amount of a growth promoter that appeared similar to IAA when examined chromatographically, using isopropanol/ammonia/water as the solvent, and a decrease of an inhibitor similar to inhibitor-β. The results showed that the acid growth-promoters and inhibitors regulate the winter rest period of P. palustris, *or are closely connected with its regulation. FA*

Allen, R. M. 1964. CONTRIBUTIONS OF ROOTS, STEMS, AND LEAVES TO HEIGHT GROWTH OF LONGLEAF PINE. Forest Sci. 10: 14-16.
Pinus palustris *Mill. saplings made 31 percent of their normal spring elongation from food reserves in the woody stem. The roots supplied materials for an additional 15 percent when the needles were present or 29 percent in their absence. The old needles apparently furnished enough materials for 40 percent of normal elongation, but this was increased to 54 percent when the roots were partially isolated from the top by girdling.*

Allen, R. M., and McGregor, W. H. D. 1962. SEEDLING GROWTH OF THREE SOUTHERN PINE SPECIES UNDER LONG AND SHORT DAYS. Silvae Genet. 11: 43-45.
Pinus taeda, P. echinata, *and* P. palustris *from different geographical seed sources were grown under (1) short (9.5-hour) and (2) long (15-hour) photoperiods.* P. taeda *of southern provenances made greater growth under both (1) and (2) than norther provenances. Seedlings of* P. echinata *grown under (1) showed clinal variations, similar to those of* P. taeda; *under (2), however, there were significant differences suggestive of ecotypes.* P. palustris *grew quicker under (2) than (1) but no significant differences could be distinguished in the different geographical provenances. This may be because the* P. palustris *seed was representative of a smaller latitudinal range than in the other species. FA*

Allen, R. M., and Naylor, A. W. 1960. STUDIES ON THE GROWTH SUBSTANCES IN LONGLEAF AND SLASH PINES. Assoc. Southern Agr. Workers Proc. 57: 251-252.
Paper chromatography and bioassay of growth substances in the epicotyls of longleaf revealed no differences that might explain the dwarf growth habit.

Barnes, R. L., and Naylor, A. W. 1961. UTILIZATION OF RADIOACTIVE ORNITHINE BY GERMINATING EMBRYOS OF LONGLEAF AND SLASH PINES. Forest Sci. 7: 130-135.
Embryos from the seeds of these pines, germinated 0-15 days, were incubated in phosphate buffer at pH 6.6 with DL-ornithine-2-C^{14} for 24 hours. Trends in the use of the ornithine carbon skeleton are shown by two-way chromatographic and autoradiographic techniques and findings discussed. Protein hydrolysates made after the incubation showed radioactive arginine, proline, and glutamic acid. A complete ornithine-urea cycle was not established in embryos of either species, no urea having been detected. FA

Boyer, W. D., and Evans, S. R. 1967. EARLY FLOWERING IN LONGLEAF PINE RELATED TO SEED SOURCE. J. Forest. 65: 806.
Trees of one seed source produced 71 percent of the female flowers on pines from 11 seed sources planted at two locations in Alabama.

Brown, C. L. 1958. STUDIES IN THE AUXIN PHYSIOLOGY OF LONGLEAF PINE SEEDLINGS. *In* Physiology of Forest Trees, Part VII, Chapter 26, pp. 511-525. K. V. Thimann (ed.) N. Y.: Ronald Press.
The mechanism controlling the short shoot habit of longleaf pine may be fundamentally different from that observed in ginkgo.

Brown, C. L. 1964. THE SEEDLING HABIT OF LONGLEAF PINE. Ga. Forest Res. Counc. Rep. 10, 68 pp.
A comprehensive investigation was made of the physiological processes associated with hypocotyl extension in longleaf, loblolly, and Sonderegger pines. The grass stage in longleaf is under rigid genetic control, but the length of time individual seedlings remain in it is strongly influenced by environment. Of the methods studied, none promoted height growth during the first year from seed.

Burns, R. M. 1960. RESPONSE OF SELECTED CONIFEROUS SEEDS TO GIBBERELLIC ACID. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1: 13-16.
In tests on unstratified seeds (450 per species) with gibberellic acid as 10 percent K salt in concentrations of 0, 75, 150, 225, and 300 mg. per liter in various forms, with or without a supplement, response was erratic within and between species. None of the seeds of Juniperus virginiana *germinated but 62 percent of the seeds recovered at the conclusion of the experiment, after 90 days, were apparently viable. The effect on germination of* Pinus palustris *was not significant, but responses appeared to increase with concentration, and distilled water appeared to be the best carrier. For* P. taeda, *germination rate, total germination, and height growth were significantly improved, being greatest at 150 mg. per liter. In a second series, in which* P. taeda *seed was stratified at 34° F. for 1 to 4 days in peat soaked with aqueous solutions of gibberellic acid in strengths from 6 to 200 mg. per liter, germination was not significantly affected, but height growth responded positively to concentration and duration of treatment, with a maximum for 3 days at 150 mg. FA*

Cain, S. A., and Cain, L. G. 1944. SIZE-FREQUENCY STUDIES OF PINUS PALUSTRIS POLLEN. Ecology 25: 229-232.
As the result of a study of variability in pollen of Pinus palustris *from widely-scattered localities in the eastern United States the author concludes that the size-frequency method of species identification is of limited application where species differ only slightly with respect to size characteristics. FA*

Campbell, T. E., and Wakeley, P. C. 1961. POSSIBLE REFINEMENTS IN CONTROLLED POLLINATION OF SOUTHERN PINES. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 121-128.
Itemizes the "Placerville" stages of longleaf pine flowers for bagging, pollination, and debagging to attain certain degrees of seed set and freedom from contamination, and evaluates laboratory germination of pollen in terms of fertilizing ability.

Davis, T. S. 1962. EFFECT OF COBALT-60 GAMMA RADIATION ON PINE SEED AND ONE-YEAR-OLD SEEDLINGS. Forest Sci. 8: 411-412.
Irradiation of (a) loblolly, (b) slash, and (c) longleaf pine seed with 10, 20, 30, 40, and 50 thousand r. at 620 r. per minute showed survivals at 4 months for the 10,000-r. treatment of 28, 32, and 0 percent for (a), (b), and (c), vs. 46 and 57 percent for controls of (a) and (b). Dormant 1-year seedlings of (a) were exposed to 3, 4, 5, 6, and 7 thousand r. at 7.95 r. per minute. Eight months later all were dead. Similar seedlings, exposed to 500, 1,300, 1,800, 2,300 and 2,800 r. at 2.70 or 6.95 r. per minute, after 8 months' growth

appeared to be affected by intensity of, as well as total, dosage. Survival was slightly better for controls than for the 500-r. treatment; after dosages > 500 r., survival and growth decreased sharply. Similar results were obtained for seedlings of (b). FA

Derr, H. J. 1963. BROWN-SPOT RESISTANCE AMONG F_1 PROGENY OF A SINGLE, RESISTANT LONGLEAF PARENT. Forest Genet. Workshop Proc. 1962: 16-17. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm.
Resistance of open-pollinated progeny of a resistant parent was greatly superior to that of controls on lightly, moderately, and severely infected sites, in terms of survival, rate and degree of infection, and continuance of height growth at age 4. Selfed progeny were as resistant, but slower to start height growth, and initially had longer and finer-textured foliage. Progeny of nonresistant mothers and the resistant parent were less susceptible than their open-pollinated half-siblings. Resistance appeared to be due to a physiological condition of foliage restricting the pathogen's ability to infect. FA

Dorman, K. W. 1956. PROGRESS IN THE SELECTION OF SUPERIOR STRAINS OF SOUTHERN PINES. Assoc. Southern Agr. Workers Proc. 53: 151-152.
Variations in growth rate, fusiform rust infection, and crown width among progeny of superior mother trees indicate that important traits are strongly inherited and selection of superior types is possible.

Eggler, W. A. 1961. STEM ELONGATION AND TIME OF CONE INITIATION IN SOUTHERN PINES. Forest Sci. 7: 149-158.
Multiphase stem growth (successive elongation from successive buds in one growing season) is common in Mississippi and Louisiana pines (P. palustris, P. elliottii, P. taeda, P. echinata). *Branches elongate in one-four phases, this being characteristic of young trees. Three procedures were used to determine the initiation period of cones: (1) weekly collection and dissection of buds from several trees; (2) mass collection of buds from one side and at a later date from the other side of a tree, a comparison of the number of recognizable primordia in the two collections indicating when most cones form; (3) cutting off ca. 12 primary or secondary buds on each of two trees just above the bud base. After (3), one case occurred of a branch producing ♀ cones in its first year, and it is assumed therefore that cones were initiated after the date of disbudding. FA*

Ferré, Y. de. 1956. ÉTUDE D'UNE PLANTULE ANORMALE DE PINUS PALUSTRIS. Soc. d'Hist. Nat. Bull. 91(3/4): 416-417. *Also in* Trav. Lab. Forest. 1(5): 4. Toulouse.
Anatomical study of a seedling without cotyledons.

Ferrill, M. D., and Woods, F. W. 1966. ROOT EXTENSION IN A LONGLEAF PINE PLANTATION. Ecology 47: 97-102. *Also in* Diss. Abstr. 25: 730. 1964.
Root extension in a 24-year-old longleaf pine plantation in the North Carolina sandhills was studied by the application of 10 mc. of I^{131} directly to the soil, on the surface, or at depths of 1 or 3 feet, and surrounding trees monitored with a portable scintillation counter. Within 10 feet of the point of application, all trees above 3.0 inches absorbed I^{131} in sufficient quantities to be detected. Beyond 22 feet for surface applications, and 33 feet for 1- and 3-foot depths, no I^{131} was detected in any trees. Regressions were computed to determine whether root extension could be predicted. When distance from the point of application was used as the dependent variable, an index of competition and the angle from the tree row proved to be the most useful, to the exclusion of the various measures of tree size.

Florida School of Forestry. 1957. LONGLEAF PINE HYBRIDS. Fla. Sch. Forest. Res. Rep. 4, pp. 25-26.
Comparison of natural and artificial hybrids of Pinus palustris × P. elliottii *var.* elliottii *with South Florida slash pine* (P. elliottii *var.* densa) *leads to the conclusion that the latter may have originated through introgressive hybridization between slash and longleaf pines.*

Garin, G. I. 1958. LONGLEAF PINES CAN FORM VIGOROUS SPROUTS. J. Forest. 56: 430-431.
Five-year-old Pinus palustris *in Alabama were cut at ground level with an ax. Six months later all the stumps that had all or part of the root collar left had produced vigorous shoots with dense foliage. FA*

Hare, R. C. 1965. BREAKING AND ROOTING OF FASCICLE BUDS IN SOUTHERN PINES. J. Forest. 63: 544-546.
Pinching the branch tips of longleaf, slash, loblolly, shortleaf and spruce pines forced fascicle buds into active growth, but only 23 of 6,239 active-budded fascicles rooted when dipped in 8,000 p.p.m. IBA in talc and inserted in perlite under intermittent mist. Species, age, and season of pinching strongly influenced both bud breaking and rooting. FA

Hesseltine, C. W., and Snyder, E. B. 1958. ATTEMPTS TO FREEZE-DRY PINE POLLEN FOR PROLONGED STORAGE. Bull. Torrey Bot. Club 85: 134-135.
A report on unsuccessful attempts to adapt to Pinus palustris *methods used to treat fungus spores for storage. FA*

Hough, W. A. 1964. AN INVESTIGATION OF SURFACE ROOT DISTRIBUTION IN LONGLEAF PINE-TURKEY OAK-STAND USING RADIOIODINE. Diss. Abstr. 25: 731-732.
I^{131} was introduced into the soil at various points in the stand, and surrounding trees were monitored for radioactivity. Maximum distance for detection of I^{131} in pine was 55 feet, and 48.7 feet for oak.

Kaloyereas, S. A., Mann, W. F., Jr., and Miller, J. C. 1961. EXPERIMENTS IN PRESERVING AND REVITALIZING PINE, ONION, AND OKRA SEED. Econ. Bot. 15: 213-217.
Partial drying can extend the viability of pine seed stored both above and below freezing point. For longleaf pine, drying to 8 percent moisture aided in preserving viability at subfreezing temperatures. Drying to 5 percent was preferable for storing at room temperature.

Kraus, J. F. 1959. METHOXONE TREATMENT OF LONGLEAF PINE SEED. J. Forest. 57: 650.
Seeds were soaked at room temperature for 24 hours in aqueous solutions of methoxone and then rinsed and sown. Concentrations of methoxone at > 500 p.p.m. proved toxic to longleaf pine seed, and the effect of low concentrations was either too short-lived or did not stimulate the desired acceleration of height growth and early seedling development. FA

Kraus, J. F., and Johansen, R. W. 1960. A TEST OF GIBBERELLIC ACID ON LONGLEAF PINE. J. Forest. 58: 194.
Tests on the response of Pinus palustris *to a 200 p.p.m. solution of gibberellic acid at the Lake City Research Center in March 1957 gave negative results. Treatments, with 60 seedlings in each, were: dipping the entire plant; dipping the root system only; dipping the foliage to the root collar; and an untreated control. Four months after planting, survivals were 45, 62, 68, and 88 percent respectively. The differences were significant at the 1 percent level of probability. Untreated controls looked the most vigorous. FA*

McCulley, R. D. 1945. GERMINATION OF LONGLEAF PINE SEED AT HIGH AND LOW TEMPERATURES. J. Forest. 43: 451-452.
Earlier experiments have indicated that temperatures much above 80° F. are unfavorable to germination of longleaf pine (Pinus palustris) *seed. In order to make a direct comparison between germination at high and low tempera-*

tures an experiment was set up in which samples from each of two lots of seed were cooled with ice to about 65° F. and comparable samples were allowed to remain at laboratory temperatures of 85-100° F. Total germination in 25 days was 49 and 64 percent for the two ice-cooled samples of seed and 14 and 18 percent for the two samples of seed at laboratory temperatures. Of the seed which remained ungerminated at the end of 25 days, 9 and 24 percent of the ice-cooled and 41 and 63 percent of seed at laboratory temperature was found to be sound, a further indication of the inhibitory effect of high temperature upon germination of seed of this species.

McGregor, W. H. D. 1960. EFFECT OF PHOTOPERIOD ON NURSERY GROWTH, OUTPLANTING SURVIVAL, AND SUBSEQUENT GROWTH OF SLASH, LONGLEAF, AND SAND PINE. Assoc. Southern Agr. Workers Proc. 57: 252-253.
Longleaf grown under long (20-hour) and normal photoperiods showed no difference in height growth in the nursery or in field survival and growth. Normal-day seedlings had more foliage.

Maki, T. E. 1963. BETTER FOREST MANAGEMENT THROUGH BETTER ADAPTATION. Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 12-15.
Marked differences in longleaf pine root systems seem to be related to origin of seed, the more fibrous root systems being associated with seed from the more moist habitats. Errors in adaptation of species to site are mentioned, including replacing longleaf with slash and loblolly on deep sands and other droughty sites.

May, J. T., Johnson, H. H., and Gilmore, A. R. 1962. CHEMICAL COMPOSITION OF SOUTHERN PINE SEEDLINGS. Ga. Forest Res. Counc. Res. Pap. 10, 11 pp.
Samples of Pinus taeda, P. palustris, *and* P. elliottii *were collected from three nurseries over a period of 6 years. Nutrient concentrations in needles, stems, and roots were found to be influenced by inheritance, organ sampled, stage of development, season, years or cyclic effects, ferilization, cover crops, sawdust in the soil, MeBr soil fumigation, and irrigation.*

Mayer, A. M., and Poljakoff-Mayber, A. 1963. THE GERMINATION OF SEEDS. 236 pp. Oxford: Pergamon Press.
A review of a wide literature field including: Structure of seed and seedlings; chemical composition of seeds; factors affecting germination; dormancy inhibition and stimulation; metabolism of germinating seeds; the effect of germination inhibitors and stimulators on metabolism; and the ecology of germination, with many examples from woody species. FA

Mergen, F. 1953. GUM YIELDS IN LONGLEAF PINE ARE INHERITED. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 29, 2 pp. *Also in* Nav. Stores Rev. 62(47): 18-19. *Also in* AT-FA J. 15(5): 14, 17.
Gum yield is an inherited character in longleaf pine. In a study started in 1935 at Lake City, Florida, it has been found that gum yields of 17-year-old longleaf pine trees from above-average mother trees are significantly higher than yields from below-average trees.

Mergen, F. 1953. SELECTION AND BREEDING OF LONGLEAF PINE. Nav. Stores Rev. 63(7): 12-14, 23-26.
See second entry below.

Mergen, F. 1953. SELECTION AND BREEDING OF SLASH AND LONGLEAF PINE AT LAKE CITY, FLORIDA. Second Southern Conf. on Forest Tree Impr. 7 pp. *Also in* Eleventh Congr. Proc., Int. Union Forest. Res. Organ. Sect. 22, pp. 481-487. 1954.
A species improvement program established in 1941 at the Forest Service's research center in Lake City, Florida, aims to develop superior strains of longleaf and slash pine for naval stores.

Mergen, F. 1954. IMPROVING THE EARLY GROWTH OF LONGLEAF PINE. Forest Farmer 13(11): 8-9, 16-17, 19. *Also in* Nav. Stores Rev. 64(3): 12-13, 21.
Early growth can be accelerated with genetically improved stock, but some time will elapse before such stock is developed.

Mergen, F., and Pomeroy, K. B. 1954. TREE IMPROVEMENT RESEARCH AT THE LAKE CITY, FLORIDA, RESEARCH CENTER. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 45, 59 pp.
Superior attributes sought are rapid growth, disease resistance, better stem form, and improved grain or density of wood.

Mergen F., Rossoll, H., and Pomeroy, K. B. 1955. HOW TO CONTROL THE POLLINATION OF SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 58, 14 pp.
A description of the technique, with illustrations of the various steps, e. g., isolation of ♀ flowers, collection of ♂ catkins, extraction of pollen, and pollination, including equipment and records. FA

Namkoong, G. 1963. COMPARATIVE ANALYSES OF INTROGRESSION IN TWO PINE SPECIES. Diss. Abstr. 24: 1801.
A study was made of the form of introgression between longleaf (Pinus palustris) *and loblolly* (P. taeda) *pine in western Louisiana. Intermediate F_1 types are being continually produced in the area and a bidirectional gene flow into both longleaf and loblolly pine is occurring. The directions of introgressive influence seem to be related to site factors.*

Nelson, R. M. 1952. OBSERVATIONS ON HEAT TOLERANCE OF SOUTHERN PINE NEEDLES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 14, 6 pp.
Needles of loblolly, longleaf, slash, and pitch pine were immersed in water at temperatures from 50 to 64° C. At 60° C, needles for all species were killed almost instantly.

Parker, J. 1959. SEASONAL VARIATIONS IN SUGARS OF CONIFERS WITH SOME OBSERVATIONS ON COLD RESISTANCE. Forest Sci. 5: 56-63.
Sucrose, glucose, and fructose, often found in the warmer months, usually increased in winter in the bark and leaves of six conifers investigated in New York State. Suspected raffinose and stachyose increased in autumn to early winter in the bark of all and in the leaves of some of these. Similar increases of these two sugars occurred in deciduous hardwoods (six spp.) but not in broadleaved evergreens. In Pinus strobus *(one tree) the branch- and root-wood contained four or five of these sugars in winter and only sucrose in summer, at the levels sampled. In the branch- and root-bark, all five sugars markedly increased in winter while starch reached minima in midsummer throughout the tree and in winter in the aerial parts only. Leaves of* P. palustris *seedlings (exotic, from the Deep South), grown in the open, did not develop in winter the high sugar content, freezing resistance or indication of stachyose found in* P. strobus, *similarly grown. Greenhouse seedlings of both species had in winter less sugar and more starch and less cold resistance than those grown in the open though their hardiness increased somewhat in spring. FA*

Parker, J. 1961. SEASONAL TRENDS IN CARBON DIOXIDE ABSORPTION, COLD RESISTANCE, AND TRANSPIRATION OF SOME EVERGREENS. Ecology 42: 372-380.
In a study at New Haven, on a 10-year-old Chamaecyparis pisifera *growing in the open and 3-year seedlings of* Pinus

sylvestris and P. palustris *growing (a) in the open, (b) in a greenhouse. CO_2 absorption (tested in the open for all plants) continued to be high in November (when leaf fall was nearly complete) gradually declined towards nil in late January in the open, and started again in early April (well before general bud opening). In (b), high values were occasionally recorded throughout the winter. Seasonal changes in cold tolerance and in transpiration were roughly but not closely similar. In* P. palustris, *in particular, winter increase in cold resistance was the same in (a) and (b). This moderate increase, and the slightly greater one in (b) for* P. sylvestris, *which appeared to be independent of temperature, is attributed to the effect of shorter days. There was no seasonal change in leaf water contents. Maximum cold tolerances are given for the following species:* P. palustris *−24°* C., C. pisifera *−43°*, Rhododendron *spp. —48°*, Taxus baccata *—56°*, Tsuga canadensis *—58°*, P. sylvestris *−80°, and* P. strobus *lower than −77°. FA*

Perry, T. O. 1954. CONTROLLED POLLINATION OF PINE SPECIES IN NORTH AMERICA. J. Forest. 52: 666-671.
Flower stages of longleaf pine strobili are illustrated with photographs.

Pomeroy, K. B. 1953. BETTER TREES FOR TOMORROW. Nav. Stores Rev. 63(20): 19, 21-22. *Also in* AT-FA J. 16(2): 18.
Propagation and controlled breeding, proven methods of the horticulturist and agronomist, are now being used in developing superior strains of longleaf and slash pine.

Saylor, L. C. 1967. VARIABILITY OF CHROMOSOME STRUCTURE AND BEHAVIOR IN SOUTHERN PINE HYBRIDS. Ninth Southern Conf. on Forest Tree Impr. Proc. 1967: 95-100.
Variability of chromosome structure and behavior was studied in three species and ten hybrid combinations of Pinus echinata, P. elliottii *var.* elliottii, P. palustris, *and* P. taeda. *Loblolly, longleaf, shortleaf, and slash pines appear compatible enough to allow interspecific hybrids, including three-way crosses, to be formed and to develop normally.*

Schopmeyer, C. S. 1953. A REVIEW OF SOME PHYSIOLOGICAL ASPECTS OF OLEORESIN FLOW FROM SLASH AND LONGLEAF PINE. Assoc. Southern Agr. Workers Proc. 50: 172.
Oleoresin flow from wounds stop after about 1 week, probably because crystallized resin plugs the ducts. Dehydrating agents applied to the wound prolong the flow to 2 weeks, probably by inhibiting the occlusion of water released by the wounded tissue. Spraying with 50 percent sulfuric acid is the most effective treatment for prolonging gum flow.

Snyder, E. B. 1961. EXTRACTING, PROCESSING, AND STORING SOUTHERN PINE POLLEN. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 191, 14 pp.
Recommends extracting pollen from ripe strobili in dry, warm, moving air and storing it at 22 percent relative humidity and 32° F.

Snyder, E. B. 1961. MEASURING BRANCH CHARACTERS OF LONGLEAF PINES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 184, 4 pp.
From measurements of all mature branches on 48 longleaf trees it was deduced that the best place to determine inherent branch angles and diameters was a "zone of equilibrium" in the middle crown where diameters of successive branches down the bole increased in proportion to bole diameter.

Snyder, E. B. 1961. RACIAL VARIATION IN ROOT FORM OF LONGLEAF PINE SEEDLINGS. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 53-59.
In a study of root forms of 20 provenances from Georgia and one each from Mississippi, Alabama, and Louisiana, the root systems of seedlings from east Georgia appeared to be more fibrous and to have more lateral roots, the progenies with the most roots usually also having the greatest total root length. Root length was not related to seedling size. It is suggested that the fibrous root form may be related to the wetter summers and autumns of the region. FA

Strohl, M. J., and Seikel, M. K. 1965. POLYPHENOLS OF PINE POLLENS: A SURVEY. Phytochemistry 4: 383-399.
Pollen of Pinus taeda, P. strobus, P. resinosa, P. elliottii *var.* elliottii, P. banksiana, P. ponderosa, P. echinata, *and* P. palustris *was analyzed. Phenolic acids and coumarate esters varied little with species, but the flavonoid fraction and the carbonate-soluble material from the ether extractives were promising for taxonomic diagnosis. FA*

Texas Forest Service. 1953. FIRST PROGRESS REPORT, FOREST TREE IMPROVEMENT PROGRAM OF THE TEXAS FOREST SERVICE. Texas Forest Serv. Cir. 35, 14 pp.
Describes genetics research, including the selection and testing of "superior" longleaf pines.

Wakeley, P. C., and Campbell, T. E. 1954. SOME NEW PINE POLLINATION TECHNIQUES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 136, 13 pp.
Illustrates flower development stages in longleaf pine. Discusses pollination techniques and simple equipment for controlled breeding of southern pines.

Woods, F. W. 1960. GIBBERELLIC ACID FAILS TO STIMULATE GROWTH OF LONGLEAF PINE SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1: 17.
Height growth was not promoted by foliage sprays of gibberellic acid in oil or water.

Wright, J. W. 1962. GENETICS OF FOREST TREE IMPROVEMENT. FAO Forest. and Forest Prod. Study 16, 399 pp.
Contains 12 sections: (1) Illustrations of basic genetic principles in forest trees (24 refs.); (2) Population genetics—mutation, migration, population size; (3) Population genetics—selection and pollination mechanisms (24 refs.); (4) Migration rates and population sizes in forest trees (19 refs.); (5) Individual tree selection and selective breeding (73 refs.); (6) Geographic variation in forest trees (with special reference to Acer saccharum, Fraxinus americana, Larix decidua, L. leptolepis, Picea abies, Pinus contorta, P. echinata, P. palustris, P. elliottii, P. pinaster, P. ponderosa, P. resinosa, P. sylvestris, P. taeda, Populus balsamifera, P. deltoides, P. trichocarpa, Pseudotsuga taxifolia, *and* Quercus*) (56 refs.); (7) Species and racial hybridization (with special reference to* Pinus, Picea, Abies, Larix, Araucaria, Populus, Quercus, Castanea, Aesculus, Acer, Eucalyptus, *and* Betula*) (133 refs.); (8) Tree introduction (with special reference to Australia, New Zealand, S. Africa, Trinidad and Tobago, Kenya, France, Italy, Great Britain, and the N. E. United States) (40 refs.); (9) Polyploidy and its importance in tree breeding (57 refs.); (10) Experimental design and analysis (15 refs.); (11) Controlled pollination (32 refs.); and (12) Vegetative propagation (34 refs.). FA*

17 SYSTEMATIC BOTANY

DeVall, W. B. 1945. A BARK CHARACTER FOR THE IDENTIFICATION OF CERTAIN FLORIDA PINES. Fla. Acad. Sci. Proc. 1944: 101-103.
The appearance of the cork cambium or phellogen layer has proved to be a useful diagnostic feature in the identification of native Florida pines. The native species having ivory-white, conspicuous phellogen lines are Pinus australis *Michx f.*, P. palustris *Mill.*, P. echinata *Mill.*, P. caribaea *Mor.*, P. glabra *Walt.*, *and* P. clausa *Engelm.* In the remaining two species (P. taeda *L. and* P. serotina *Michx.)*

the lines are inconspicuous or, at most, slate-grey in color. This bark character has been particularly useful for separating P. taeda *from* P. palustris *in the Gainesville area when other characters failed. FA*

Fernald, M. L. 1948. THE CONFUSED BASES OF THE NAME PINUS PALUSTRIS. Rhodora 50: 241-249.
Account of the circumstances that led to the name Pinus palustris. *Suggests that* Pinus australis, *a name given by Michaux, would be preferable.*

Grelen, H. E., and Duvall, V. L. 1966. COMMON PLANTS OF LONGLEAF PINE-BLUESTEM RANGE. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-23, 96 pp. Southern Forest Exp. Sta., New Orleans, La.
Descriptions and botanical drawings of more than 80 understory species, with notes on values for cattle and wildlife.

Langdon, O. G., Bomnard, M. L., and Cassady, J. T. 1952. FIELD BOOK OF FORAGE PLANTS ON LONGLEAF PINE-BLUESTEM RANGES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 127, 117 pp
Illustrated descriptions.

Mirov, N. T. 1967. THE GENUS PINUS. 602 pp. New York: Ronald Press Co.
Comprehensive treatise: history, paleobotany, geography, genetic aspects, morphology and reproduction, physiology and ecology, chemical aspects, chemical geography, and taxonomy. Various references to Pinus palustris.

Wahlenberg, W. G. 1945. LONGLEAF PINE. I. Southern Lumberman 171(2153): 168-170.
Distinctive characteristics of longleaf pine. Also uses, strength, durability, and pulping characteristics of the wood.

West, E., and Arnold, L. E. 1946. PINUS PALUSTRIS MILL. —LONGLEAF PINE, YELLOW PINE, SOUTHERN PINE (PINACEAE: PINE FAMILY). *In* The Native Trees of Florida, p. 8, Gainesville: Univ. Fla. Press.
Description, distinguishing characteristics, and general comments. Drawings of cones, needles, and seed.

Wood, J. W. 1952. CANDLES IN THE WILDERNESS. Frontiers 16: 80-81.
Photographs and brief popular description of longleaf pine vegetative buds (candles).

18 PLANT ECOLOGY

Allen, R. M. 1956. RELATION OF SAW-PALMETTO TO LONGLEAF PINE REPRODUCTION ON A DRY SITE. Ecology 37: 195-196.
On a dry ridge in Mississippi, Pinus palustris *seedlings were found only near clumps of Serenoa repens. Apparently the palmetto shade protected the seedlings from lethal temperatures and improved their water relations.*

Allen, R. M. 1965. LONGLEAF PINE (PINUS PALUSTRIS MILL.). *In* Silvics of Forest Trees of the United States, pp. 384-389. U. S. Dep. Agr., Agr. Handbook 271.
A very complete summary of silvical characteristics.

Boyer, W. D. 1956. TIME OF LONGLEAF SEEDFALL. U. S Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 102.
In a better-than-average crop in south Alabama the last viable seed was trapped on October 14 and the last on February 6, with the bulk falling between October 24 and November 21, 1955.

Boyer, W. D. 1958. LONGLEAF PINE SEED DISPERSAL IN SOUTH ALABAMA. J. Forest. 56: 265-268.
Number of sound seeds dispersed from forest walls into openings was halved with each 55-link increase in distance from the seed source. Seventy-one percent fell within 1 chain of the base of the parent trees.

Boyer, W. D. 1963. DEVELOPMENT OF LONGLEAF PINE SEEDLINGS UNDER PARENT TREES. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-4, 5 pp. Southern Forest Exp. Sta., New Orleans, La.
In southwest Alabama, unburned seedlings under overstories ranging up to 90 square feet of basal area per acre survived as well as those with no tree competition. After 7 years, milacre stocking averaged 99 percent and survival 72 percent. Growth, but not survival, improved with distance from parent trees. Seedlings under tree crowns had less brown spot than those in the open.

Boyer, W. D. 1963. LONGLEAF PINE SEED DISPERSAL. U. S. Dep. Agr. Forest Serv. Res. Note SO-3, 2 pp. Southern Forest Exp. Sta., New Orleans, La.
Two transects of seed traps were established at right angles to each of four forest walls enclosing a rectangular 80-acre clearing in 65-feet-high, 40- to 50-year Pinus palustris *in Alabama. Seed production was 104,000 sound seeds per acre in 1955 and 1958, 19,000 in 1957, and nil in 1956. Of sound seed trapped beyond the edges of the forest walls, 71 percent fell less than 1 chain from the base of the parent trees, and the number dispersed was halved with each 55-link increase in distance from the seed source. FA*

Boyer, W. D. 1966. LONGLEAF PINE POLLEN DISPERSAL. Forest Sci. 12: 367-368.
A high ratio of pollen drift to deposition and the high level of pollen found in an open area suggest that Pinus palustris *forests fill the air with pollen that travels for long distances, with density declining mostly through diffusion rather than fallout.*

Boyer, W. D., and Fahnestock, G. R. 1966. LITTER IN LONGLEAF PINE STANDS THINNED TO PRESCRIBED DENSITIES. U. S. Dep. Agr. Forest Serv. Res. Note SO-31, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Reports a study to determine the effects of stand density of even-aged second-growth Pinus palustris *in southeast Alabama on the composition, deposition, and accumulation of litter on the forest floor. The relation of litter weight to stand basal area was exponential, and pine needles constituted 70 percent of the trapped litter. The mean weight of material on the forest floor, excluding the miscellaneous partly decayed material, ranged from 2,587 to 4,256 pounds per acre exponentially according to stand density. There was a significant negative curvilinear correlation between grass weight and stand density. The amount of flash fuel increased rapidly with increase of basal area, but its total weight did not become great enough, under stands of up to 50 square feet per acre, either to support a high-intensity fire or to equal 2 years' deposition of needles. It is concluded that, in the absence of significant quantities of flammable brush, prescribed burning for hazard reduction alone does not seem to be warranted in such light stands. FA*

Burk, C. J. 1959. A FLORISTIC STUDY OF A SANDHILL AREA ON THE NORTH CAROLINA COASTAL PLAIN. J. Elisha Mitchell Sci. Soc. 75(2): 135-138.
The following plant communities were observed: (1) a xeric ridge community with Pinus australis (P. palustris) *as the dominant tree species in association with* Quercus laevis *and* Aristida stricta; *(2) a pocosin community composed of elliptic-leaved evergreen Ericaceous species and hollies, succeeded by members of the bay forest; (3) and ecotonal community composed of members of both the adjoining ridge and pocosin communities, as well as elements unique to the ecotone; and (4) disturbed communities of cutover pine forests, old fields, and roadsides. FA*

Campbell, R. S. 1955. VEGETATIONAL CHANGES AND MANAGEMENT IN THE CUTOVER LONGLEAF PINE-SLASH PINE AREA OF THE GULF COAST. Ecology 36: 29-34.
Secondary plant succession in the longleaf pine slash pine belt of the Gulf Coastal Plain is influenced by timber cutting, burning, and grazing. The damaging effects of wildfire and of uncontrolled annual burning are in part alleviated by their replacement in managed stands by prescribed burning, which is useful in reproducing and growing longleaf pine and slash pine stands and in improving grazing. Hogs and sheep are serious threats to the early survival and growth of both longleaf and slash pines, but cattle usually allow the stands to develop with little disturbance. The scrubby hardwoods and underbrush that naturally develop when only the pines are cut or when complete fire protection is practiced constitute a problem on which more and more attention is being focused. Increasing intensity of land management for timber growing and range grazing is aggravating conditions of soil fertility and physical condition which may soon be reflected in stand structure and growth of both trees and grass. These problems should be attacked from the ecological viewpoint.

Chapman, H. H. 1950. LIGHTNING IN THE LONGLEAF. Amer. Forests 56(1): 10-11, 34.
Gives evidence for the theory that Pinus palustris *represents a fire climax and meteorological data to show the probability of lightning having been the cause of this development long before man-made fires occurred.*

Chapman, H. H. 1950. LONG-LEAF YELLOW PINE OWES ITS EXISTENCE TO FIRE. Coastal Cattleman 16(3): 10-13.
Speculates on the role of lightning fires, before the advent of man-caused fires, in the ecology of longleaf pine. An estimated 150,000 acres were burned annually by lightning fires in Alabama, Florida, Louisiana, Mississippi, and Texas. These fires favored the development of pure stands of longleaf.

Collingwood, G. H., and Brush, W. D. 1947. LONGLEAF PINE (PINUS PALUSTRIS MILL.). *In* Knowing Your Trees, pp. 54-55. Amer. Forest. Assoc. Wash., D. C.
A popular description, including botanical and silvical characteristics and economic importance.

Cooper, J. R. 1946. THE SILVICULTURAL MANAGEMENT OF LONGLEAF PINE. M. S. Thesis. Yale Univ. Sch. Forest. New Haven, Conn.
Broad treatise, covering tree characteristics, silvicultural characteristics, management, and utilization.

Croker, T. C., Jr. 1952. EARLY RELEASE STIMULATES CONE PRODUCTION. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 79.
In southern Alabama, longleaf pine seed trees that were released from competition for 32 months before cones matured produced almost four times as many cones as trees with only 8 months of release.

Croker, T. C., Jr. 1958. SOIL DEPTH AFFECTS WINDFIRMNESS OF LONGLEAF PINE. J. Forest. 56: 432.
A survey of trees felled by hurricane Flossy in 1956 indicated that longleaf pines on the Escambia Experimental Forest in south Alabama were most susceptible to windthrow where surface soils were underlain by clay at a shallow depth. Restricted root development on shallow soils, along with greater saturation during rainstorms, is believed to be primarily responsible.

Davis, V. B. 1955. DON'T KEEP LONGLEAF SEED TREES TOO LONG! U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 98.
When some 3-year-old longleaf pine seedlings were burned to control brown-spot needle blight, it was found that seedling mortality was highest close to the overstory pines, where seedlings were smaller and heavy needle cast added to the fuel supply.

Derr, H. J., and Enghardt, H. 1957. SOME FORESTRY LESSONS FROM HURRICANE AUDREY. Southern Lumberman 195 (2441): 142-144.
Slash pine was hit harder than loblolly or longleaf, chiefly because it has been widely planted on poorly drained flatwood sites, where a high degree of windfirmness cannot be expected. Much of the loss was in windthrow of dominant and codominant trees. Stands below merchantable size were damaged mainly by breakage of fusiform-infected stems. Dense stands were harmed less than some that had recently been heavily thinned.

DeVall, W. B. 1943. THE CORRELATION OF SOIL PH WITH DISTRIBUTION OF WOODY PLANTS IN THE GAINESVILLE AREA. Fla. Acad. Sci. Proc. 6(1): 9-24.
A study was made to obtain specific data on the relationship between soil acidity and the species and distribution of woody plants present in the Gainesville district, Florida. The seven areas selected for study represented the following major forest types: (1) pine flatwoods, (2) mixed hardwood hammock, and (3) scrub oak ridge. All trees within a radius of 20 feet and all associated shrubs within a radius of 10 feet of a soil sample were tallied. Of the 68 species included in the study, 28 occurred on definitely alkaline soils, 28 on neutral soils, 41 on slightly acid soils with a pH of 6.0-7.0, 50 on moderately acid soils (pH of 5.0-6.0), 12 on strongly acid soils (pH of 4.0-5.0), and one (Pinus palustris) *on an extremely acid soil with a pH of 3.8. The species are grouped in five fidelity classes according to sociological tendencies to mix with other plants on a large scale or to be exclusive. FA*

DeVall, W. B. 1952. INVASION OF A LONGLEAF PINE SITE BY SLASH PINE AND INFERIOR HARDWOODS. Ala. Acad. Sci. J. 22: 106-107.
On the Little River State Forest in south Alabama, slash pine seedlings have invaded a longleaf site where fires have not burned since 1934.

Dorman, K. W., and Barber, J. C. 1956. TIME OF FLOWERING AND SEED RIPENING IN SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 72, 15 pp.
Tabulates approximate dates in 1956 for pollen and seed ripening for slash, longleaf, loblolly, and shortleaf pines throughout their natural ranges, with similar data from a few stations for some minor pine species. There was a strong correlation between time of pollen ripening and latitude. FA

Gaines, E. M. 1950. SCRUB OAK HELPS LONGLEAF SEEDLINGS ON DEEP SANDS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 69. *Also in* Nav. Stores Rev. 60(28): 2.
Observations of first-year seedlings in Alabama during 1948 and 1949 showed that seedlings on deep sands survived late spring drought better when shaded by scrub oak than in the open. FA

Gaines, E. M. 1952. SCRUB OAK AS A NURSE CROP FOR LONGLEAF PINE ON DEEP SANDY SOILS. (Abstr.) Ala. Acad. Sci. J. 22: 107-108.
Initial establishment was better under hardwood crowns than in the open, presumably because of improved soil moisture and reduced seedling transpiration. After the pines are well established, perhaps in a year or less, the scrub oak nurse trees become competitors.

Gaines, E. M., Campbell, R. S., and Brasington, J. J. 1954. FORAGE PRODUCTION ON LONGLEAF PINE LANDS OF SOUTHERN ALABAMA. Ecology 35: 59-62.
A study was made in second-growth longleaf pine [Pinus palustris] *lands in southern Alabama to determine relationships between production of grasses and forbs and several ecological factors. Herbage production decreased as the basal area of the tree stand increased. The curvilinear regression showing this relationship is highly significant statistically, but accounts for only 14 percent of the variation in herbage production. Distribution of the tree stand also affects herbage production. A single longleaf pine tree, 7 to 14 inches d.b.h., influences grass production only 6 to 8 feet from the trunk, while a group of trees reduces herbage production up to 20 to 30 feet away from the forest wall. Weight of tree litter was closely associated with herbage production. The linear regression is highly significant statistically, and accounts for 21 percent of the variation in herbage production. Three major upland soil groups were recognized in this study. The mean herbage production per acre (adjusted to average litter weight) by soil groups was: soils with clay subsoils—860 pounds, soils with loam subsoils —680 pounds, and deep sands—470 pounds. Soil groups and litter weight together account for 31 percent of the variation in herbage production. Herbage production was highest on moist sites favorable to slender bluestem. Uplands produced about 2.75 times as much grass as did the bottom lands. Since bottom-land soils are basically more productive than upland soils, the difference is attributed to heavy brush and tree competition in the bottoms. FA*

Gemborys, S. R. 1967. VEGETATION AND HABITAT OF SMALL STREAM BRANCH-BOTTOMS OF SOUTHWESTERN ALABAMA. Diss. Abstr. 28: 4018-B.
A phytosociological investigation was made in branch bottoms interlacing longleaf forests in southwestern Alabama. Species frequency was determined on a variety of sites ranging from dry to wet and from burned to unburned. Ranking of leading species from dry to wet (and most burned to least burned) sites was: Cornus florida, Pinus palustris, Quercus nigra, Liquidambar styraciflua, Nyssa sylvatica *var.* sylvatica, P. elliottii *var.* elliottii, *and* N. sylvatica *var.* biflora.

Greene, J. T., and Reines, M. 1959. REPRODUCTION OF LONGLEAF PINE OUTSIDE ITS NATURAL RANGE. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 35, pp. 26-27.
Records natural regeneration of Pinus palustris *in a plantation at Athens, Georgia, ca. 60 miles northwest of the nearest natural limits of the species. FA*

Grelen, H. E. 1962. PLANT SUCCESSION ON CLEARED SANDHILLS IN NORTHWEST FLORIDA. Amer. Midland Natur. 67: 36-44.
Annual composites such as Balduina angustifolia, Erigeron pusillus, *and* Aplopappus divaricatus *dominated the earliest stage of succession. Annual grasses were scarce, but two perennials,* Panicum malacon *and* Leptoloma cognatum, *came in quickly. At the end of 4 years,* Eupatorium compositifolium *was the dominant herbaceous plant.* Andropogon virginicus *increased steadily after the second year. Scrub oaks and* Aristida stricta, *which dominate uncleared areas, occurred only as scattered plants.*

Harkin, D. A. 1962. DIAMETER GROWTH PERIODICITY OF SEVERAL TREE SPECIES IN THE SOUTH CAROLINA COASTAL PLAIN. Forest Sci. 8: 363-370.
Presents data from weekly readings of the basal area and radial growth at breast height for Pinus elliottii *and* P. taeda, *showing also the variation in their initiation and cessation of growth in three seasons, with further information on this duration of seasonal growth for* P. palustris, Nyssa sylvatica, Quercus nigra, *and* Q. stellata. *FA*

Hedlund, A., and Janssen, P. 1963. MAJOR FOREST TYPES IN THE SOUTH. U. S. Dep. Agr. Forest Serv. Southern and Southeast. Forest Exp. Stas., 1 p.
Map, in color, at scale of 40 miles to the inch.

Hough, W. A., Woods, F. W., and McCormack, M. L. 1965. ROOT EXTENSION OF INDIVIDUAL TREES IN SURFACE SOILS OF A NATURAL LONGLEAF PINE-TURKEY OAK STAND. Forest Sci. 11: 223-242.
In the sandhills of North Carolina, I-131 was introduced to soil at selected spots, absorbed by roots, and translocated. Radioactivity was detected in pine stems as far as 55.1 feet from plot center and in oak stems out to 48.7 feet. All pines within 17 feet of plot center showed contact with the isotope source, and all oaks within 15 feet. Factors most closely related to distance of root extension were elevation and tree age for longleaf, and age and tree hight for turkey oak.

Janssen, P., and Weiland, M. R. 1960. SOFTWOOD DISTRIBUTION MAPS FOR THE SOUTH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Forest Surv. Release 83, 12 pp.
The maps present the relative concentration and approximate range in 12 Southern States, of 11 species (Pinus palustris, P. elliottii, P. taeda, P. echinata, P. serotina, P. virginiana, P. clausa, P. strobus, Taxodium distichum, Tsuga *spp. and* Juniperus *spp.). FA*

Laessle, A. M. 1958. THE ORIGIN AND SUCCESSIONAL RELATIONSHIP OF SANDHILL VEGETATION AND SAND-PINE SCRUB. Ecol. Monogr. 28: 361-387.
The strongly washed and sorted siliceous sands and clays of peninsular Florida are occupied by scrub vegetation where drainage is good or by hammock where fire has been excluded or minimized. Other well-drained deposits, less severely washed and sorted, are occupied by the longleaf pine/turkey-oak association. Circumstantial evidence indicates that the differences in flora of these communities are due to nutritional differences. In absence of fire both of those communities would be succeeded by evergreen hardwoods, known as hammocks.

Lemon, P. C. 1949. SUCCESSIONAL RESPONSES OF HERBS IN THE LONGLEAF-SLASH PINE FOREST AFTER FIRE. Ecology 30: 135-145.
A greater number of species participate in the ground cover in the first 3 years following a fire than after 8 years of fire protection. The greater variety of forage plants on a fresh burn is probably a dietary advantage to cattle. Various morphological adaptations seem to be of value for rapid aggregation of plants on burns. Many of the fire followers have a large number of small seeds, frequently windborne, supplemented by rhizomes, crown buds, and tillers. FA

McLemore, B. F., and Derr, H. J. 1965. LONGLEAF PINE CONE MATURITY IS INDEPENDENT OF POLLINATION DATE. Silvae Genet. 14: 133.
Period of seed development is constant for individual trees but varies between trees. The order of cone ripening is nearly identical from year to year.

Monk, C. D. 1966. EFFECTS OF SHORT-TERM GAMMA IRRADIATION ON AN OLD FIELD. Radiat. Bot. 6: 329-335.
A 12-year-old field that had been planted in longleaf pine 5 years previously was exposed for 400 hours to a 9,200 c Cs^{137} irradiator in May 1965. Exposure for 400 hours was not sufficient to establish vegetation zones corresponding to different radiation levels; however, Fimbristylis autumnalis *did invade the 160 kR zone following exposure.*

Changes in floristic composition along a radiation gradient each lifted a 50 percent reduction in similarity and diversity at 530 and 750 R per day respectively. Root biomass production decreased with increased radiation. The reduction was related to direct radiation damage and to indirect damage through the death of shoots followed by root degradation. Terminal stem elongation in longleaf pine was reduced to 50 percent by 1 R per day. At the end of the 1965 growing season, mortality resulted in all pine that received 9,000 R.

Muntz, H. H. 1954. HOW TO GROW LONGLEAF PINE. U. S. Dep. Agr. Farmers' Bull. 2061, 25 pp.
Topics include: reasons for growing longleaf pine, tree characteristics, how to establish and manage the stand, marketing the crop, naval stores, and dual use of forests to produce cattle as well as trees.

Parker, J. 1965. THE ABILITY OF WARM-CLIMATE PINES TO BECOME COLD HARDY. Pakistan J. 15: 156-160.
Needles from seedlings of (a) Pinus taeda *and* (b) P. palustris *were tested for resistance to low temperature from summer into midwinter in south Connecticut:* (b) *was capable of hardening from −10 to −15° C. Greenhouse seedlings did as well in this respect as those grown in the open, suggesting the lack of a temperature induction mechanism for hardiness development;* (a) *was capable of hardening from ca. −12 to −14° C., but only in the case of field-grown seedlings. The general weakness of the hardening mechanism in these two species helps to support the idea that low temperatures limit their northern geographical range. FA*

Pessin, L. J., and Chapman, R. A. 1944. THE EFFECT OF LIVING GRASS ON THE GROWTH OF LONGLEAF PINE SEEDLINGS IN POTS. Ecology 25: 85-90.
Longleaf pine (Pinus palustris) *seedlings were grown for a period of 2 years in 1-gallon metal containers in some of which grass was sown while the remainder were kept free of grass. Two watering schedules were tested at 250 and 500 ml. weekly. Where pines were grown with grass (pure broomsedge and a mixture of other species), the vegetation cover was either (a) burned off once a year, the ashes being returned to the soils in the containers, (b) clipped twice a year, or (c) left undisturbed ('rough') as a check. The average dry weight of the pine seedlings grown in cultures without grass was significantly greater than that of seedlings grown in cultures with grass in the rough condition, but it was not significantly influenced either by mulching or by the amount of water applied. Analysis of the seedlings grown with grasses under the three different conditions (a, b, and c) noted above, showed that the average dry weight of pines grown with burned broomsedge was significantly greater than that of pines grown with clipped broomsedge, which in turn was significantly greater than the average dry weight of those grown with 'rough' broomsedge. No significant differences in average dry weight appeared, however, among pines grown with mixed species other than broomsedge, subjected to the same three treatments. Of the pines grown with broomsedge, those receiving 500 ml. of water showed a significantly greater average dry weight than those receiving 250 ml., though this difference was not observed for pines growing with mixed grasses other than broomsedge. FA*

Quarterman, E., and Keever, C. 1959. CLIMAX FOREST OF THE LONGLEAF PINE BELT OF THE SOUTHEASTERN UNITED STATES. Proc. 9th Int. Bot. Congr., Vol. 2, p. 315.
The seral position of hardwood stands on upland sites in this Coastal Plain belt has been in question. Phytosociological studies, in which widely distributed stands were sampled, have been made over a 3-year period. Soils from each of the sampled stands were also analyzed mechanically and for major nutrients. These studies have established the continuity throughout the area of a mixed hardwood type of forest unified by certain binding species in a way similar to the various portions of the mixed mesophytic forest of Braun. Data obtained provide evidence for regarding this mixed hardwood type as the regional climax. FA

Smith, L. F. 1955. DEVELOPMENT OF LONGLEAF PINE SEEDLINGS NEAR LARGE TREES. J. Forest. 53: 289-290.
If pine litter is removed periodically, large pines and oaks may be left for 5 or 6 years without causing severe mortality among pine seedlings. Earlier removal is preferable, however.

Smith, L. F. 1961. GROWTH OF LONGLEAF PINE SEEDLINGS UNDER LARGE PINES AND OAKS IN MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 189, 4 pp.
When brown-spot needle blight was controlled, longleaf seedlings survived and started height growth near large pines and oaks. Oaks were severer competitors than pines.

Smith, L. F. 1966. EARLY FLOWERING IN LONGLEAF PINE. J. Forest. 64: 198-199.
One tree bore female flowers after its fourth year in plantation, many trees had male or female flowers after the fifth year. Annual cultivation appears to promote early flowering in longleaf.

Stone, E. L., Jr., and Stone, M. H. 1954. ROOT COLLAR SPROUTS IN PINE. J. Forest. 52: 487-491.
A study of six species of pine showed that 'root-collar' shoots arise from buds in the axils of primary needles, those just above the cotyledons generally bearing these buds most abundantly. The assumption (from their occurrence below lateral roots) that shoots may arise from root tissues is due to distortion, subsequently concealed by growth. No adventitious buds were found, and decapitation below cotyledons resulted in no regeneration of shoots. That these buds produce coppice shoots in older stems after long dormancy is of minor silvicultural interest but it is important in the survival of seedlings injured by fire, grazing or cutting and even in normal nursery conditions (P. palustris). *FA*

Tall Timbers Research Station. 1962. TALL TIMBERS RESEARCH STATION FIRE ECOLOGY PLOTS. Tall Timbers Res. Sta. Bull. 2, 179 pp. Tallahassee, Fla.
Plant lists, photos, and sketch maps for 84 square ½-acre fire ecology plots established in 1959.

Wahlenberg, W. G. 1946. LONGLEAF PINE. II—NATURAL DISTRIBUTION OF LONGLEAF PINE AND THE ROLE OF FIRE IN ITS REGENERATION. Southern Lumberman 172(2154): 64-66.
Fire furnished the primary control of the distribution of longleaf under natural conditions, largely through its effects on competing species. In managed stands, some burning is essential to secure reproduction and to prevent a hardwood invasion. Frequent fires have a slightly beneficial effect on chemical composition of surface soil and a slightly detrimental effect on physical properties.

Wahlenberg, W. G. 1946. LONGLEAF PINE: ITS USE, ECOLOGY, REGENERATION, PROTECTION, GROWTH AND MANAGEMENT. 429 pp. Wash., D. C.: Charles Lathrop Pack Forest. Found. and U. S. Dep. Agr. Forest Serv.
This comprehensive monograph renders accessible to the forester, timber grower, research worker, and teacher much information, some of it previously unpublished, on the resources, uses, silviculture and management of Pinus palustris. *Part 1 deals with resources, uses and properties; Part 2 with ecology, including a chapter on the role of fire in regeneration of longleaf pine; Part 3 with problems of natural and artificial regeneration; Part 4 with protection from*

fire, insects, diseases, animals and climatic injuries; and Part 5 with management, including chapters on naval stores operation and growth and yield of longleaf pine trees and stands. Each chapter is briefly summarized. Eleven appendices include a glossary, stand tables, diameter and height tables, volume tables, normal growth and yield tables for second-growth longleaf pine. There are 74 original text figures, 48 plates, a bibliography of over 600 references, and a subject index. FA

Wakeley, P. C., and Campbell, T. E. 1960. SEEDLESS LONGLEAF CONES CAN MATURE AND OPEN. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 127.
In a pollination study in Louisiana, where mixed fresh longleaf pine pollen was applied to bagged flowers on three trees, the ratios of cones produced to flowers pollinated, and of seeds to cone, varied greatly. On one tree, 30 pollinated flowers yielded but one cone and this contained no seed. FA

Walker, L. C., and Davis, V. B. 1954. FOREST WALLS RETARD YOUNG LONGLEAF. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 93. *Also in* Southern Lumberman 189(2369): 117.
Border trees of longleaf timber stands slowed the growth of seedlings as far as 55 feet into openings. Large trees (over 11 inches d.b.h.) had a greater effect than small border trees.

Walker, L. C., and Davis, V. B. 1956. SEED TREES RETARD LONGLEAF PINE SEEDLINGS. J. Forest. 54: 269.
Longleaf pine seed trees reduced the survival and growth of seedlings for at least 50 feet—well beyond the reach of the tree crowns.

Walker, L. C., and Wiant, H. V., Jr. 1966. SILVICULTURE OF LONGLEAF PINE. Stephen F. Austin State Coll. Sch. Forest. Bull. 11, 105 pp.
Growth, natural reproduction, artificial reproduction, genetics, thinning, pruning, competition control, range management, game management, prescribed burning, destructive agents, and nutrition of longleaf pine forests.

Wilhite, L. P., and Ripley, T. H. 1965. IMPORTANT UNDERSTORY PLANTS OF THE SLASH-LONGLEAF FLATWOODS. Ga. Forest Res. Counc. Res. Pap. 29, 4 pp. *Also in* AT-FA J. 27(11): 11-14.
Plots were established in the slash-longleaf flatwoods of southeast Georgia and northeast Florida to determine disturbance succession of the understory and response of planted slash pines to increasing intensities of site preparation. This paper describes understory plant communities in the interval between clear cutting of the overstory and burning and harrowing of the sites in preparation for tree planting.

Woods, F. W. 1957. FACTORS LIMITING ROOT PENETRATION IN DEEP SANDS OF THE SOUTHEASTERN COASTAL PLAIN. Ecology 38: 357-359.
Root penetration of all species is very shallow on these sandhills; fertility is poor, field capacity small, and the water table at least 40-50 feet below the surface. The scrub oak (mainly Quercus laevis *and* Q. incana*) and* Pinus palustris*, like all other species, form a thick mat of fibrous roots within 4-5 inches of the surface. Below this are a few large roots and almost no small ones. The factors influencing this form of root system are the superior moisture, nutrient status, and temperature in the surface soil. FA*

Woods, F. W. 1959. SLASH PINE ROOTS START GROWTH SOON AFTER PLANTING. J. Forest. 57: 209.
Root growth had started 22 days after planting on all four slash pines in the trial, but on only two of the four longleaf pines and on two of the four sand pines. Observations in other years supported these findings. FA

Zobel, B. J., and Goddard, R. E. 1954. PINE FLOWERING AND SEED RIPENING IN TEXAS. Tex. Forest Serv. Res. Note 8, 10 pp.
Phenological data on Pinus palustris, P. taeda, P. elliottii, P. echinata, *and* × P. sondereggeri. *FA*

2. SILVICULTURE

22 SILVICULTURAL SYSTEMS

Croker, T. C., Jr. 1956. CAN THE SHELTERWOOD METHOD SUCCESSFULLY REGENERATE LONGLEAF PINE? J. Forest. 54: 258-260.
Regeneration of longleaf pine by the seed tree method has been unsuccessful because of inadequate seed crops, invasion of the site by brush and grass, and other problems. Recent results suggest that a modified shelterwood system may be feasible. Some needed research is proposed.

Korstian, C. F., Maki, T. E., Ostrom, C. E., and Scheer, R. L. 1954. DESIRABLE CUTTING PRACTICES FOR NORTH CAROLINA FORESTS. N. C. Forest. Assoc., 22 pp. Raleigh.
Recommendations for several types: Eastern white pine, mountain cove, loblolly-shortleaf pine, Virginia pine, longleaf pine, pond pine, and bottom land hardwoods of the Coastal Plain.

Perry, J. H., and Riebold, R. J. 1965. STRIP CLEAR-CUTTING TO REGENERATE LONGLEAF PINE. Southern Lumberman 211 (2632): 153-154.
A 45-year-old stand of longleaf pine was regenerated by clearing and disking strips 200 to 300 feet wide and leaving intervening seed-source strips 1 chain in width. Milacre stocking averaged 60 percent, with good distribution over the cleared strips. When cattle and hogs had access to the area, the damage was disastrous.

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

Bateman, B. A., Roark, C. B., and Harris, H. E. 1967. NATURAL LONGLEAF REPRODUCTION AND ESTABLISHMENT IN SOUTHWESTERN LOUISIANA. La. State Univ. LSU Forest. Notes 74, 2 pp.
Stands can be established where seed supply is adequate, seedlings are protected from hogs, and prescribed fire is used properly.

Bickford, C. A., and Bruce, D. 1948. FIRE AND LONGLEAF PINE REPRODUCTION. Southern Lumberman 177(2225): 133-135.
In order to study the effect of different seedbeds on the natural regeneration of longleaf pine (Pinus palustris)*, an area on the Dry Prong Tract in central Louisiana was fenced and protected from fire at the time of the 1935 seedfall. When the seedlings were 0 year old various kinds of controlled burning were tried. Fresh burns and 1-year roughs*

(land burned and left fallow for a year) had much the highest survival of first-year seedlings. Burning once or twice after the seedlings were a year old gave a better 6-year-old survival than no burning or annual burning. FA

Boyer, W. D. 1964. NEW LIFE FOR AN OLD FAVORITE. Southern Lumberman 209(2609): 99-101.
The difficulty in obtaining Pinus palustris *regeneration is commonly attributed to: poor seed production; poor seedling establishment due to destruction by birds, mammals, and insects; low seedling survival due to inability to survive prolonged competition from trees, weeds, etc.; and poor subsequent growth due to competition and* Scirrhia acicola *attack during the grass statge. A recent experiment in Alabama, however, showed that: maximum (and sufficient) sound seed production per acre was reached under a parent crop density of basal area 35 to 50 square feet per acre; 80 percent of seedlings, protected from fire, survived and were healthy after 7 years under a crop density of basal area 90 square feet per acre, although height increment was suppressed even by quite thin overstories;* S. acicola *attack was inhibited by the canopy; and, even after 8 years' suppression, seedling response to release by felling the overstory was prompt. Grass stage seedlings appear to be resistant to logging damage. Experiments on other site types are required. FA*

Boyer, W. D. 1965. NATURAL REGENERATION OF LONGLEAF PINE: A NEW LOOK AT AN OLD PROBLEM. Ala. Forest Prod. 8(10): 53-56.
Recent research suggests that longleaf pine on many sites can be regenerated from seedling stands established under relatively full parent overstories.

Bruce, D. 1949. LONGLEAF REGENERATION IMPROVED BY BURNING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 60.
Fire improves seed catch, increases survival, and stimulates height growth.

Bruce, D. 1949. SEED LOSS TO BIRDS UNIMPORTANT ON FRESH BURNS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 63.
In south Mississippi in 1947 and 1948, birds ate very little of the Pinus palustris *seed on several small, fresh burns having heavy seed supplies, and the difference between open and screened plots was not great. The greatly increased catch of seedlings on the screened compared with the open plots on old rough was probably due to the discouragement of rodents. FA*

Bruce, D. 1950. IT ISN'T THE ASHES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 66.
Rapid early growth of longleaf seedlings on spots where pine logs have recently burned seems due to the action of the fire in killing grass roots rather than any fertilizing or mulching effect of the ashes.

Bruce, D. 1956. YOUNG LONGLEAF DO BEST ON FRESH BURNS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 101.
Age of rough influences early growth and survival.

Bruce, D., and Bickford, C. A. 1950. USE OF FIRE IN NATURAL REGENERATION OF LONGLEAF PINE. J. Forest. 48: 114-117.
In a study on a 1,000-acre tract in Louisiana, 1-year roughs and fresh burns gave the best seedbeds. Burning once or twice in a 6-year period after seedling establishment was better than no burning. Benefits of burning were especially important where seed supply was poor.

Chapman, H. H. 1948. THE INITIATION AND EARLY STAGES OF RESEARCH ON NATURAL REFORESTATION OF LONGLEAF PINE. J. Forest. 46: 505-510.
A review of research in the natural regeneration of Pinus palustris *during the last 35 years, with a summary of the conditions now generally accepted as essential (1) all competition by brush and other trees to be reduced by cutting and burning; (2) burning must be done before seedfall, preferably during the preceding winter; (3) winter burning must be carried out in the third and fifth years to eliminate brown-spot disease and competing vegetation; (4) fire must then be excluded until the crop is above 3 feet in height, after which winter burning can be resumed at 3- to 5-year intervals throughout the life of the stand, as a protection against destruction by hot summer fires; (5) where seed trees are inadequate and planting is necessary, fire should be used in the same way. FA*

Croker, T. C., Jr. 1957. SCALPING AIDS LONGLEAF SEEDLING CATCH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 112.
Scalping the seedbed just before seedfall more than doubled the catch of longleaf pine on a sandy site in southern Alabama.

Croker, T. C., Jr. 1959. SCALPING STIMULATES LONGLEAF GROWTH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 121.
On a sandy ridge in southern Alabama, scalping the seedbed just before seedfall markedly increased the number of longleaf pine seedlings that began height growth in their third year.

DeVall, W. B. 1952. FACTORS AFFECTING THE ESTABLISHMENT OF LONGLEAF PINE SEEDLINGS FROM THE 1947 SEED CROP. Ala. Acad. Sci. J. 21: 16-20.
A dense understory of hardwoods was related to inadequate stocking from a heavy seed crop in southern Alabama. Seedling densities were highest on sites with grassy covers, lowest on sites with leaves and needles but no grass. Soils with clay within 12 inches of the surface usually had good catches of seedlings; deep sandy soils were inadequately stocked.

Kircher, J. C. 1944. SEED CROP SAID TO BE BEST IN YEARS. AT-FA J. 6(4): 8-9. *Also as* BURN NOT THESE TINY SEEDS; THE FORESTS OF TOMORROW MUST COME FROM TODAY'S LONGLEAF PINE SEED CROP. Ala. Conserv. 15(7): 5, 12.
The 1944 longleaf pine seed crop is the best since 1935. Landowners should provide fire protection for the germinating seedlings.

Laros, J. W. 1961. PRESCRIBED BURNING HELPS MOUNTAIN LONGLEAF IN ALABAMA NATIONAL FORESTS. Southern Lumberman 203(2537): 126-127.
Prescribed burning is beneficial for control of brown spot and for seedbed preparation in mountain longleaf stands and has been successful on slopes of 10 to 15 percent. Usually burning is done in September and October within 5 days after a measurable rain. Fires are set on ridgetops and allowed to burn downslope.

Lemon, P. C. 1946. PRESCRIBED BURNING IN RELATION TO GRAZING IN THE LONGLEAF-SLASH PINE TYPE. J. Forest. 44: 115-117.
Studies in southern Georgia show that prescribed burning improves the forage for grazing. It may also be beneficial in fire-hazard reduction, seedbed preparation, and control of brown-spot disease. Careful planning and extreme care are necessary in using fire.

McMinn, J. W. 1966. SITE PREPARATION AIDS LONGLEAF REGENERATION. J. Forest. 64. 385-387.

A study in Florida tested effects of four site treatments on the regeneration of naturally seeded longleaf pine (4 to 6 seed trees per acre). Treatments were: (1) burning alone; (2) burning, followed by strip-harrowing; (3) burning, followed by a single harrowing; (4) burning, followed by a double harrowing. Treatments were begun in September 1961, and the study conducted through January 1963. Weather was unfavorable during the 1961 seedfall, and the 1962 seedfall was negligible; thus overall stocking was very low. Stocking for the most intensive treatment was nine times that for burning alone.

Maki, T. E. 1952. LOCAL LONGLEAF SEED YEARS. J. Forest. 50: 321-322
In southern Mississippi there have been nine medium or better, and 14 light or better, longleaf pine seed crops since 1930. Thus a light or better crop occurred twice in every 3 years.

Mann, W. F., Jr., and Derr, H. J. 1958. REGENERATION OF UNDERSTOCKED LONGLEAF STANDS . . . SKILL NOT LUCK! Forests and People 8(2): 20-21, 53.
A 256-acre tract in central Louisiana was regenerated from the bumper 1955 seed crop. Regeneration measures included fencing out hogs and cattle, a seedbed burn in March 1955, cutting trees not needed for seed, supplemental sowing of Morkit-treated seed on 100 acres where seed trees were scarce, and controlling Texas leaf-cutting ants. At the end of the first year there were 5,720 seedlings per acre.

Morriss, D. J., and Mills, H. O. 1948. THE CONECUH LONGLEAF PINE SEEDBED BURN. J. Forest. 46: 646-652.
A prescribed burn was made on 26,000 acres of the Conecuh National Forest in southern Alabama between August 1 and October 31, 1947. The aim was to prepare the site to receive a bumper longleaf seed crop. Results were good; stands of 4,000 or more seedlings per acre became established on 73 percent of the area.

Smith, L. F. 1961. TREE PERCENT ON BURNED AND UNBURNED LONGLEAF SEEDBEDS. J. Forest. 59: 201-203.
Establishment of Pinus palustris *seedlings was studied on (a) plots burned before seedfall to eliminate ground cover and (b) unburned control plots in six stands in south Mississippi. Stocking after 1½ years was much superior on (a) (2,467 seedlings per acre vs. 800 for (b)). Details are given of the sampling technique used and the distribution of seed and seedlings. FA*

Wahlenberg, W. G. 1946. LONGLEAF PINE. III—SEEDS, SEEDBEDS, AND SEEDLINGS. Southern Lumberman 172(2155): 32.
A discussion of regeneration problems, including natural regeneration, direct seeding, nursery practice, and planting.

Wakeley, P. C. 1947. THE 1947 CONE CROP AND FOREST FIRES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 51. *Also in* Forest Farmer 6(12): 5. *Also in* Southern Lumberman 175(2201): 184.
At least 2,000 cones per acre are required for natural regeneration of longleaf pine. A good cone crop, far in excess of these minimum requirements, is reported for the fall of 1947 from Alabama to Texas. Fire should be excluded from the stands resulting from this crop until the seedlings are at least 1 year old.

Walker, L. C. 1954. EARLY SCRUB-OAK CONTROL HELPS LONGLEAF PINE SEEDLINGS. J. Forest. 52: 939-940. *Also in* Southern Lumberman 189(2369): 169-170.
Survival and growth of seedlings released (by Ammate poisoning) during the first year after germination, were significantly greater than in those released in the second and third years, and in unreleased plants. Where the oak was poisoned one year before germination, diameter growth was significantly less, owing to grass invasion, than in plots released at germination. FA

232 ARTIFICIAL REGENERATION

232.1 CHOICE AND TRIAL OF SPECIES

Anonymous. 1947. LONGLEAF AND SLASH PINES (PINUS PALUSTRIS AND PINUS CARIBAEA). Del. State Forest. Dep. Rep. 1946-47, p. 22.
Planted trees did best on well-drained sandy soils free of competing vegetation. Snow and frost caused little more damage than to native P. taeda.

Anonymous. 1947. SEED PROVENANCE. Rep. Dep. Forest. South Afr., 1946, pp. 6-7.
In 1941 precocious seedlings of P. palustris *were noticed in the nursery at Kwambonambi Plantation, and a test was made of their subsequent growth. Fifty-six months later, they averaged 20.4 feet in height and 5.1 inches in d.b.h., as compared to 13.9 feet and 3.2 inches for normal longleaf seedlings.*

Anonymous. 1949. EXOTIC PINES IN NORTHERN RHODESIA. Rep. Forest. Dep. N. Rhodesia, 1948, p. 8.
A review was made of test plantings made at Ndola (lat. 13°, altitude 4,000 feet). Definitely slow growers are P palustris, P. arizonica, P. echinata.

Allen, P. H. 1961. FLORIDA LONGLEAF PINE FAIL IN VIRGINIA. J. Forest. 59: 453-454.
Highly significant differences were found in 6-year survival and height of Pinus palustris *from seed sources in Florida, Louisiana, Mississippi, Georgia, and Virginia, planted in Nansemond County, Virginia. Height and survival were not significantly related to temperature zone, latitude, or longitude of seed source. The Florida source had poorest survival and height. The local source appeared best. FA*

Bateman, B. A. 1954. CHOICE OF SPECIES AND STAND COMPOSITION. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 34-39.
Various ecologic factors affect suitability of longleaf, slash, loblolly, and shortleaf pines for planting. Slow height growth is a prime reason for longleaf's lack of popularity in planting programs.

Bateman, B. A., and Roark, C. B. 1954. *In* Research in agriculture, 1952-53, pp. 231-233. La. State Univ. Agr. Exp. Sta. Annu. Rep.
See next entry.

Bateman, B. A., and Roark, C. B. 1955. *In* Research in agriculture, 1953-54, pp. 267-268. La. State Univ. Agr. Exp. Sta. Annu. Rep.
Brief account of recently installed studies. A stand averaging 2,350 seedlings per acre was obtained from longleaf seed trees on an area burned before seedfall; the stand on an unburned area averaged 534. In the first year of a fertilizer trial, longleaf seedlings receiving a 60-60-60 mixture, plus lime, grew taller than unfertilized trees.

Bethune, J. E., and Roth, E. R. 1960. SOURCE OF SEED AFFECTS GROWTH OF LONGLEAF PINE—FIFTH YEAR RESULTS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 146, 2 pp.
Discusses seedling height, seedling survival and branch length, time in grass stage, percent of trees forked, and percent infected by brown-spot needle blight.

Box, B. H., Linnartz, N. E., and Applequist, M. B. 1964. GROWTH OF SLASH AND LOBLOLLY PINE IN A MIXED PLANTATION IN SOUTHWESTERN LOUISIANA. La. Agr. Exp. Sta. LSU Forest. Notes 58, 3 pp.
In an 80-acre experiment on a poorly drained, clear-felled

Pinus palustris *site in southwest Louisiana, five mixtures were planted at 6 × 6 feet in 1952, viz: (1) and (2) 4- and 8-row* P. palustris + P. elliottii, *(3) 4-row* P. palustris + P. taeda, *(4) and (5) 2- and 4-row* P. taeda + P. elliottii. P. palustris *showed only 27 percent survival after 2 years, and of the survivors 70 percent were infected with* Scirrhia acicola. *After 11 years, only (4) and (5) showed promise, (4) being best.* P. elliottii, *which had better height, d.b.h., volume per acre, and resistance to* Cronartium fusiforme, *though lower survival, is preferable to* P. taeda *on poorly drained sites. FA*

Collins, A. B., III. 1964. LONGLEAF PINE SEED SOURCE PLANTING IN GEORGIA—TENTH YEAR RESULTS. U. S. Dep. Agr. Forest Serv. Res. Note SE-19, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Six seed sources of longleaf pine at age 10 show height growth correlated with latitude or temperature. The greatest difference in height, 4.7 feet, was between the Coastal Plain and the Piedmont sources in Alabama. Since only 0.2 foot separated the Georgia and Texas sources, longitude appears to have little effect on height growth. An average survival of 80 percent for the entire study and average height of 25 feet at age 10 indicate that species diversification is practical on suitable sites.

Derr, H. J. 1966. LONGLEAF × SLASH HYBRIDS AT AGE 7: SURVIVAL, GROWTH, AND DISEASE SUSCEPTIBILITY. J. Forest. 64: 236-239.
Hybrids planted in central Louisiana are demonstrating desirable characteristics of both parent species. They closely resemble longleaf pine in form and branching habits but start height growth immediately and grow almost as fast as slash pine. They appear less susceptible than their parents to the brown-spot needle blight of longleaf and the fusiform rust of slash pine.

Garin, G. I. 1967. REESTABLISHING FOREST STANDS IN UPPER COASTAL PLAIN. Highlights Agr. Res. 14(3): 11. Auburn Univ. Agr. Exp. Sta., Alabama.
On deep sandy soil in central Alabama planted longleaf survived poorly; for this reason plantation yields at 20 years were low. Loblolly did well. Slash pine produced adequate stands on recently cultivated land but not on abandoned fields or cleared forest sites.

Gibbs, J. A. 1948. GROWTH OF TREE PLANTINGS FOR EROSION CONTROL IN THE SOUTHEASTERN REGION. Iowa State Coll. J. Sci. 22(4): 371-386.
During the past 13 years about 180 million trees have been planted in the southeastern region of the U.S.A. as part of an erosion control program. The pine species (P. taeda, P. caribaea, P. echinata, P. palustris, P. rigida, *and* P. virginiana) *have survived and grown well,* Robinia pseudoacacia *and other hardwoods badly. Pine plantings, over a wide range of conditions, have established ground cover and completely controlled erosion in 8-10 years, though longer is needed in some of the worst eroded sites.* Cronartium (Cronartium fusiforme) *cankers were frequently found, but were confined mostly to slash and loblolly pines. In most cases infected main stems can be eliminated in the first thinnings without seriously reducing stand density. Figures are given of average annual increment (diameter, height, volume) for all species used. FA*

Hamilton, J. R. 1956. AN EVALUATION OF SOUTHERN PINE PLANTATIONS IN THE GEORGIA PIEDMONT PLATEAU. Ga. Agr. Exp. Sta. Bull. N. S. 20, 41 pp.
A study was made of 103 plantations scattered through the area, to determine the effect of spacing on growth and development of stands. It was found to have a marked effect on d.b.h., basal area per acre, branch size, live crown ratio, and bark thickness, but not on total height. Spacings recommended are 4 × 4 feet for Pinus echinata *and* P. palustris, *and 6 × 8 feet for* P. taeda *and* P. elliottii. *Though* P. echinata *is not planted to any great extent on the Piedmont Plateau, it should be considered for planting in areas subject to frequent glaze storms owing to its relative immunity to deformation due to glaze damage;* P. elliottii *is very susceptible,* P. taeda *rather less so. All species respond well to good sites and are disappointing when planted on spoilmounds. FA*

Hebb, E. A. 1955. OPERATION SANDHILLS—TWO YEARS LATER. Southern Lumberman 191(2393): 159-160.
Two years after being planted on the sandhills of western Florida, slash pine has better survival, growth, and form than loblolly, shortleaf, longleaf, or Monterey pine.

Huckenpahler, B. J. 1950. DEVELOPMENT OF NINETEEN-YEAR-OLD SOUTHERN PINE PLANTATIONS IN TENNESSEE. J. Forest. 48: 722-723.
An examination was made of one plantation each of Pinus echinata, P. taeda, P. palustris, *and* P. caribaea, *near Jackson, Tennessee, where the two last are considerably north of their native range. Planting had been done on abandoned cropland already showing slight gully erosion. The stand structure of the 19-year-old plots is described. All plots now have a complete ground cover of needle and leaf litter, native grasses, shrubs, and vines; and hardwood reproduction and further loss of soil are being effectively prevented. FA*

McKinnon, A. D. 1945. DEVELOPMENT OF SOUTHERN PINES IN AUCKLAND CONSERVANCY. N. Zeal. J. Forest. 5: 127-132.
Analysis of some 5,000 acres of plantations of Pinus caribaea, P. echinata, P. palustris, *and* P. taeda *in Auckland, N. Z. It is concluded that plantings of all southern pines, except* P. palustris, *should be confined to well sheltered, lower slopes, generally below the 400-foot contour. Evidence suggests that* P. palustris *can withstand greater exposure, and establishment up to 700 feet seems justifiable. The percentage of trees of defective habit in* P. taeda *and* P. echinata *is so high that further plantings of these species should be discontinued until the development of existing stands can be followed through to a greater age. The raising of sturdy nursery stock, necessitating drastic culling in nurseries and careful treatment at all stages from nursery to planting site, is of particular importance for southern pine. It is of the greatest importance to keep planting lines opened up so as to reduce early injury to succulent shoots by the abrasive action of crowding scrub growth. Early pruning and thinning of stands are essential. FA*

Plass, W. T., and Burton, J. D. 1967. PULPWOOD PRODUCTION POTENTIAL ON STRIP-MINED LAND IN THE SOUTH. J. Soil and Water Conserv. 22: 235-238.
Discusses results of experimental plantings, especially of the oldest one, of Pinus taeda, P. resinosa, *and* P. palustris *near Jasper, Ala., in which all pines were healthy and had reached ca. 40 feet in height after 20 years, and where the best,* P. taeda, *had a stocking of ca. 20 cords per acre. It is concluded that production prospects are as good as or better than on abandoned farm lands and other shallow soils. The extent of areas involved, their ownership, physical characteristics, suitability (e.g. pH), etc. are briefly discussed. FA*

Rodger, Sir Alex. 1951. A VISIT TO SOUTH AFRICA. PART III—EXOTIC PLANTATIONS. Empire Forest. Rev. 30, 143 pp.
General account of forestry in the Union, with some details of exotic plantations. Longleaf is a slow growing tree adapted to the cooler areas. Suggested rotations are: first quality site—40 years, second quality—50 years, third quality—60 years.

Scheer, R. L. 1959. COMPARISON OF PINE SPECIES ON FLORIDA SANDHILLS. J. Forest. 57: 416-419.
So far, slash pine has performed better than loblolly, shortleaf, and longleaf. Monterey pine has been a total failure.

Scheer, R. L., and Hodges, J. D. 1960. PLANTED SAND PINE GROWS WELL ON UNPREPARED FLORIDA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1: 7-8.
On the deep sands of western Florida, sand pine planted on unprepared sites grew well with little or no release from competing vegetation. Longleaf and other southern pines did poorly without release.

Shoulders, E. 1965. SEED ORIGIN AFFECTS LONGLEAF PINE IN LOUISIANA PLANTATION. U. S. Dep. Agr. Forest Serv. Res. Note SO-19, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
In a 5-year-old plantation in central Louisiana, seed source (10 provenances) significantly affected both survival and height of Pinus palustris. *Survival was correlated with mean annual temperature, and height with the Jan.-April rainfall at the source. FA*

Smith, L. F., and Smith, H. D. 1963. GROWTH OF SLASH, LOBLOLLY, AND LONGLEAF PINES ON CULTIVATED SITES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 59, pp. 1-2.
Comparison of longleaf pine growth with that of the other two species already reported showed that though the latter were ca. 6 feet taller than longleaf at 4 years old, current annual increment was very nearly the same at that age. Early growth of longleaf was much improved by site preparation, cultivation, and brown spot control. FA

Wakeley, P. C. 1951. IMPORTANCE OF GEOGRAPHIC STRAINS. First Southern Conf. on Forest Tree Impr. 9 pp.
Geographic strains exist in loblolly and probably in longleaf and shortleaf pines. They may exist in slash but there is not much evidence. A comprehensive regional seed source study is proposed to investigate the hypothesis that geographic strains exist in the major southern pines.

Wakeley, P. C. 1953. PROGRESS IN STUDY OF PINE RACES. Southern Lumberman 187(2345): 137-140.
An interim report on a study by the permanent Committee on Southern Forest Tree Improvement on the effect of P. taeda, P. echinata, P. palustris, *and* P. elliottii *provenances on their growth in a region stretching from Maryland to Florida and west to Texas. FA.*

Wakeley, P. C. 1953. STUDIES OF GEOGRAPHICAL RACES OF SOUTHERN PINES. Nav. Stores Rev. 62(51): 12-13, 30.
General description of establishment of Southwide Pine Seed Source Study, with some account of earlier studies.

Wakeley, P. C. 1953. THE SOUTH ESTABLISHES A MAJOR PINE GEOGRAPHIC SEED SOURCE STUDY. Second Southern Conf. on Forest Tree Impr. 6 pp.
Four hypotheses will be tested. (1) That geographic races are associated with temperature zones, (2) that races are associated with rainfall zones or major soil groups within a temperature zone, (3) that races are associated with ancient land masses, (4) that geographic races do not exist.

Wakeley, P. C. 1955. SET-BACKS AND ADVANCES IN THE SOUTHWIDE PINE SEED SOURCE STUDY. Third Southern Conf. on Forest Tree Impr. Proc. 1955: 10-13.
Notes on racial variations in the nursery and early plantation phases. Losses to drought in western part of study territory necessitate additional longleaf and shortleaf pine plantations.

Wakeley, P. C. 1959. FIVE-YEAR RESULTS OF THE SOUTHWIDE PINE SEED SOURCE STUDY. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 5-11.
Seedlings from the southernmost source of longleaf pine seed, Hillsborough County, Florida, have survived poorly. There is strong evidence of racial variation in rate of height growth.

Wakeley, P. C. 1961. RESULTS OF THE SOUTHWIDE PINE SEED SOURCE STUDY THROUGH 1960-61. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 10-24.
Significant variations in survival and height appear among different geographic sources of both loblolly and shortleaf pine, especially from north to south. In longleaf they appear almost as much from east to west as from north to south. Loblolly varies significantly in fusiform rust infection, especially from east to west. Compared to these species, slash pine north and west of mid-Florida exhibits little racial variation.

Wakeley, P. C. 1963. HOW FAR CAN SEED BE MOVED? Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 38-43.
Pending definitive results from provenance tests, the author hazards 10 recommendations concerning distances and directions that southern pine seed can be moved from source to planting site.

Ware, L. M., and Stahelin, R. 1948. BEHAVIOR OF DIFFERENT PINE SPECIES UNDERPLANTED IN HARDWOOD STANDS. Rep. Ala. Agr. Exp. Sta. 1945-46, p. 29.
One-year seedlings of slash, loblolly, shortleaf, and longleaf pines were planted in regular 6 × 8 feet spacing under a dense stand of hickory, oak, and sweetgum 4-8 feet high which had come in on a clearcut longleaf pine area. On one part the pines were released 4 years after planting, on another part they were not released. Release cutting increased the survival and the growth of each species of pine but in different degrees (slash pine three times, shortleaf about six times, loblolly much less). The slash and loblolly were about equally good when underplanted and released. The shortleaf was not so well adapted to underplanting. The longleaf gave too low a rate of survival to permit study. FA

Williston, H. L. 1959. GROWTH OF FOUR SOUTHERN PINES IN WEST TENNESSEE. J. Forest. 57: 661-662.
Though planted well beyond their natural range, longleaf, slash, and loblolly pine have outgrown the native shortleaf. After 29 growing seasons, volumes per acre are 43 cords for loblolly, 39 for longleaf, 36 for slash, and 28 for shortleaf.

Williston, H. L., and Huckenpahler, B. J. 1958. RESPONSE OF SIX CONIFERS IN NORTH MISSISSIPPI UNDERPLANTINGS. J. Forest. 56: 135-137.
Immediate release greatly stimulated height growth of all species on a ridge site. Loblolly appears to be best for restocking but shortleaf and Virginia pine survive best on droughty sites. Because of poor survival and susceptibility to ice damage, slash and longleaf are not recommended. Eastern redcedar survives well but is severely browsed by deer.

Yarham, E. R. 1946. EXOTICS IN NEW ZEALAND. Wood 11 (8): 216-218. *Also as* NORTH AMERICAN SPECIES THRIVING IN NEW ZEALAND. Brit. Columbia Lumberman 29: 69-70. 1945.
The New Zealand State forests of exotics occupy just under 450,000 acres; 370,000 acres are held by over 30 companies planting exotics. The annual cut of rough-sawn exotic pine timber alone in 1941-42 was 56,247,000 board feet. The species planted in North Island in recent years have been Pseudotsuga taxifolia, *western yellow pine* (Pinus ponderosa), Pinus radiata, *and Corsican pine* (P. nigra *var.* calabrica). *The southern pines* (Pinus palustris, P. taeda,

and P. caribaea) *have shown promising results in the Auckland Conservancy. In South Island western yellow pine, Corsican pine,* Pseudotsuga taxifolia *and* Pinus radiata *are used. The last-named species has proved the most highly productive of the introduced pines. FA*

232.2 PREPARATORY WORK, AUXILIARY MEASURES

Bruce, D. 1959. EFFECT OF LOW COMPETITION ON LONGLEAF PINE SEEDLING GROWTH. Soc. Amer. Forest. Proc. 1958: 151-153.
In small-scale tests in southern Mississippi, scalping, and methods of burning that kill grass roots, particularly log burning, reduced competition and promoted growth more effectively than herbicides (allyl alcohol, TCA and others being tried). Brown-spot infection was often troublesome if not controlled, particularly on the plots without grass. Diameter at ground level at the end of the first year was a good indicator of probable start of height growth, and the need for measures to reduce competition.

Fassnacht, D. L. 1954. PREPARATION OF SOME ADVERSE SITES IN THE SOUTHEAST. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 69-79.
Discusses use of fire, chemicals, and mechanical equipment to prepare sandhill sites for planting. Best first-year survival of longleaf occurred on bulldozed sites, poorest where woody vegetation was killed with chemicals.

Langdon, O. G. 1959. SITE PREPARATION REQUIREMENTS FOR DIRECT SEEDING OF LONGLEAF AND SLASH PINES. Direct Seeding in the South, 1959, a Symposium, pp. 109-113. Duke Univ.
Examples of suitable preparation in areas of east Texas, Mississippi, Louisiana, and Florida.

Muntz, H. H. 1951. CONVERTING SCRUB OAK AREAS TO PINE PLANTATIONS. J. Forest. 49: 714-715. *Also as* RELEASING PINE PLANTED UNDER SCRUB OAK. Southern Lumberman 181 (2273): 200-201. 1950.
Loblolly, slash, and longleaf pines were planted in oak scrub and released at different times and by different methods. It was established that this process of conversion can be done successfully, provided that release is not deferred long after planting. FA

Shipman, R. D. 1955. FURROWS IMPROVE LONGLEAF SURVIVAL IN SCRUB OAK. Southern Lumberman 190(2381): 70, 72. *Also as* PLANTING IN FURROWS AIDS INITIAL SURVIVAL OF LONGLEAF IN SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 82, 2 pp.
First-year survival of one-year-old planting stock was higher (71 percent) on areas with furrows ca. 6 feet apart, 8 inches deep and with a flat base 18 inches wide, with old oaks (about 20 percent of the original number) left standing between the furrows, than in completely cleared areas (48 percent survival) those in which 45 percent of the oaks were felled and the stumps poisoned (45 percent), or in untreated controls (57 percent). Soil moisture and surface soil temperature were no more favorable on the furrowed than on the other sites, and the reason for the higher survival is not clear. FA

Shipman, R. D. 1956. FURROW OLD FIELDS TO PLANT LONGLEAF IN THE SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 98, 2 pp.
Tests when planting 1 + 0 longleaf pine seedlings in furrows 8 inches deep by 24 inches wide, near Aiken, South Carolina, on old fields with 'rough' aged 7 or 8 years, showed that soil moisture, particularly in the top 3 inches of soil, was greater and dropped below wilting point for shorter periods than on controls. The method has since been applied to 8½ million seedlings on 10,600 acres of old field, with marked superiority in initial survival compared with unfurrowed fields. FA

Shipman, R. D. 1963. SCRUB OAK CONTROL WITH FENURON PELLETS IN THE SOUTH CAROLINA SANDHILLS. J. Forest. 61: 217-220.
One-year-old longleaf and slash pine seedlings were interplanted among scrub oak (mainly Quercus laevis) *and pellets were applied 1 month after planting. First-year survival was 68 percent for longleaf and 76 percent for slash pines, with no after-treatment effects. Scrub oak mortality was satisfactory, but not greatly influenced by increasing the dosages from 30 to 60 pounds per acre. The major kill was of trees $>$ 1 inch d.b.h. Studies are continuing. FA*

Shoulders, E., and Wilson, R. H. 1962. WHY TREAT A GOOD SITE? Southern Lumberman 205(2561): 143-144.
On a good site in central Louisiana, three-fourths of the longleaf seedlings planted on disked and furrowed plots were making height growth at age 3, as compared with 43 percent on scalped or check plots. Survival averaged 80 percent on furrowed plots, 66 percent on disked plots, and 67 percent for no preparation.

Starr, J. W. 1965. THE ROLE OF HERBICIDES IN DIRECT SEEDING. Proc., Direct Seeding Workshops, Alexandria, La., and Tallahassee, Fla., pp. 5-7. U. S. Dep. Agr. Forest Serv., Atlanta, Ga.
Discusses use of herbicides for controlling scrub hardwoods on sites scheduled for direct seeding of longleaf.

232.3 SEED, NURSERY PRACTICE, DIRECT SOWING

Allen, R. M. 1953. RELEASE AND FERTILIZATION STIMULATE LONGLEAF PINE CONE CROP. J. Forest. 51: 827.
Second-growth Pinus palustris *trees were given one of four treatments: (1) release from all dominant, codominant, and intermediate trees from a radius of 17-20 feet, (2) application of 5-15-5 fertilizer, (3) a combination of (1) and (2), and (4) untreated controls. No effect was observed until the third and fourth years after treatment, when average annual cone production per tree was 6.9 for (1), 13.5 for (2), 16.7 for (3), and 1.3 for (4). FA*

Allen, R. M. 1953. STIMULATION OF LONGLEAF PINE SEED PRODUCTION. Second Southern Conf. on Forest Tree Impr. 3 pp.
Describes methods of increasing cone production by improving vigor of seed trees through release and ferilization.

Barnett, J. P. 1964. STORED LONGLEAF SEED SUCCESSFULLY DIRECT SEEDED. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 65, pp. 3-5.
Gives particulars of an experiment in sowing Pinus palustris *seed stored for 7 years in various conditions of temperature and moisture. Recommended storage conditions are temperatures of ca. 0-25° F. and seed moisture content $<$ 10 percent. FA*

Barnett, J. P., and McLemore, B. F. 1961. TREE AGE UNIMPORTANT IN LONGLEAF SEED VIABILITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 135.
In central Louisiana, neither initial germinability nor germinability after 5 year's storage differed significantly among seed from trees aged 21, 40, and 85 years.

Boyer, W. D. 1956. LAMBERT SEEDS LONGLEAF PINE. Ala. Lumberman 8(7): 12, 14, 16.
Mr. Brooks Lambert, of the T. R. Miller Mill Company, direct-seeded a dry sandy ridge in southern Alabama after

clearing off oaks and wiregrass with heavy machinery. The seed was coated with anthraquinone to repel birds.

Cossitt, F., and Tomlinson, H. 1949. PLANTING FROM THE SKIES. Southern Lumberman 179(2249): 176-177.
Describes an undertaking of the U. S. Forest Service in the southern region, where 1,230 acres were sown with Pinus palustris *from the air. The seed (3,590 pounds) was clean and dewinged. Half had been kept in cold storage since 1946, and half was fresh. It was sown from a height of about 75 feet in strips 50 feet wide. The fresh seed gave an initial establishment of 45-65 percent, and the stored seed 7-17 percent, the difference being largely due to the germination percent of the seed. Ten months after sowing it was clear that acceptable stands had been established. The success of the operation was probably due to the following factors: (1) the sowings were made in November soon after rain, (2) warm, rainy weather continued till January, and (3) the area was burned over in advance and town ant colonies were poisoned. FA*

Croker, T. C., Jr. 1959. DIRECT SEEDING LONGLEAF PINE IN SOUTH ALABAMA AND NORTHWEST FLORIDA. Ala. Conserv. 30(5): 18-19, 27.
Good results were achieved with longleaf, slash, loblolly, and shortleaf pine, but not with sand pine. Seed was coated with Arasan to repel birds and with endrin to deter rodents.

Croker, T. C., Jr. 1964. FRUITFULNESS OF LONGLEAF TREES MORE IMPORTANT THAN CULTURE IN CONE YIELD. J. Forest. 62: 822-823.
Five-year cone production of 60-year-old longleaf pines in south Alabama was influenced more by inherent fruitfulness of individual trees than by fertilization and irrigation.

Croker, T. C., Jr. 1964. TWO H-C FURROW SEEDERS. U. S. Dep. Agr. Forest Serv. Res. Note SO-5, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Describes and illustrates two machines that simultaneously prepare a seedbed and sow longleaf and other pine seed in rows. Explains the adjustment and operation of these machines behind a farm tractor.

Derr, H. 1956. AERIAL RESEEDING BOOSTS LONGLEAF PINE. Forests and People 6(1): 30, 52.
Eight thousand acres of cutover Louisiana forest land were seeded with longleaf pine in 4 weeks. Total cost per acre was $4 to $5. Much of the work was done with an airplane that covered 1,000 acres in a day. Procedures for seeding of longleaf were developed at Alexandria, Louisiana, by the Forest Service, USDA. Seed loss to birds, a crucial problem, was obviated by coating seed with Morkit, a German-manufactured repellent.

Derr, H. J. 1952. DIRECT SEEDING BY AIR. Forests and People 2(1): 20-21.
Longleaf pine was direct-seeded on 600 acres on the Kisatchie National Forest in central Louisiana. Seeding on 500 acres was done by airplane at a cost of $1 per acre for plane and personnel, including ground flagmen. A 100-acre tract was seeded with cyclone seeders at a cost of 30 to 35 cents per acre for labor. Establishment results are not given but losses to birds were heavy [the seed had no repellent treatment].

Derr, H. J. 1958. DIRECT SEEDING: A FAST RELIABLE METHOD OF REGENERATING LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 32, pp. 15-20.
Draws on 10 years of research at Alexandria, Louisiana, to make recommendations on site preparation, freshness of seed, rate and date of sowing, seed treatments, sowing methods, and evaluation of results.

Derr, H. J. 1959. TIME OF YEAR FOR DIRECT SEEDING. Direct Seeding in the South, 1959, a Symposium, pp. 114-118. Duke Univ.
February appears to be the best time for sowing loblolly, shortleaf, and possibly slash pine. Seed should be stratified and coated with repellents. Longleaf is sown unstratified, usually in late November or early December.

Derr, H. J., and Cossitt, F. M. 1955. LONGLEAF PINE DIRECT SEEDING. J. Forest. 53: 243-246.
Summarizes experience from eight trials on 8,000 acres scattered in Mississippi and Louisiana.

Derr, H. J., and Mann, W. F., Jr. 1954. FUTURE FORESTS BY DIRECT SEEDING. Forests and People 4(4): 22-23, 38-39.
In November 1953, 440 acres in Louisiana were direct-seeded at the rate of 10,000 good seed per acre. The seedbed had been burned in early 1953. Patrols were made for several weeks to keep birds away, and rabbits were controlled by night hunting. In May 1954 early establishment was good, averaging 2,500 to 3,200 seedlings per acre. A chemical bird repellent is being sought.

Derr, H. J., and Mann, W. F., Jr. 1959. GUIDELINES FOR DIRECT-SEEDING LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 171, 22 pp. Reprinted in Forest Farmer, 1960. Six parts. I.—19(4): 6-7, 15-17; II.—19(5): 16-20; III.—19(6): 28, 30, 32; IV.—19(8): 14-16; V.—19(9): 12-14, 16; VI.—19(10): 14-15.
Discusses all major aspects: choice and preparation of site; seed, seed hazards, and protection by repellents; rates, season, and methods of sowing; evaluation of results and early tending, including brown-spot control.

Dorman, K. W. 1947. LONGLEAF PINE CUTTINGS ROOTED IN GREENHOUSE. J. Forest. 45: 594.
In October 1946, 12 cuttings were taken from each of three longleaf pines [Pinus palustris] *all of at least 9 inches in diameter; eight of each set were given chemical treatments that had proved successful with slash pine and the remaining four were untreated controls. The most effective treatment was 24-hour soaking of the bases in a solution containing 15 p.p.m. traumatic acid, 15 p.p.m. sodium pentachlorophenate, 10 p.p.m. vitamin B_1, 5 percent sucrose and 0.4 percent of a commercial plant food containing essential minerals, vitamins, and hormones. Of cuttings receiving this treatment, 38 percent rooted as against none of the untreated controls. FA*

Dorman, K. W., Schopmeyer, C. S., and Snow, A. G. 1944. TOP BRACING AND GUYING IN THE BREEDING OF SOUTHERN PINES. J. Forest. 42: 140-141.
In order that breeding operations such as bagging and pollination may be carried out in slash pine (Pinus caribaea) *and longleaf pine* (P. palustris), *it is necessary to brace the tops of the trees to prevent breakage and provide efficient working conditions. Bracing consists of three pieces of 2 × 2 inch pine 10-16 feet long, firmly bound to the main stem and extending to the top of the tree. Three guy wires are fastened between the braces and nearby stumps or trees to prevent swaying. FA*

Downs, A. A. 1949. DEVELOPING BETTER PINES FOR GUM PRODUCTION. Southern Lumberman 179(2249): 233-236.
Describes methods for rooting longleaf pine cuttings. Such cuttings do not have a grass stage. Performance of slash-longleaf hybrids is discussed.

Ferguson, J. L. 1959. . . . AND DIRECT SEEDING WAS BORN. Forests and People 9(1): 6-12.
A popular account of direct seeding of longleaf pine in

Louisiana, with emphasis on problems in seeding 16,000 acres of cutover lands.

Johansen, R. W., and Kraus, J. F. 1958. PROPAGATION TECHNIQUES APPLICABLE TO LONGLEAF PINE. J. Forest. 56: 664.
Brief notes citing instances of successful propagation by cuttings, grafting, and air-layering. FA

Jones, E. P., Jr. 1963. A TEST OF DIRECT SEEDING DEPTHS FOR SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Res. Note SE-5, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
In two studies in Georgia, in nursery-type beds in a loamy sand, in which sowing depth was varied from 0 to 1¼ inches, germination percent was highest for both species at ¼ and lowest at 1¼ inches. The earliest planting dates (February) were best for germination of both species. Stratification increased germination percent of slash but not of longleaf pine. FA

Jones, L. 1963. GERMINATION OF REPELLENT-TREATED SOUTHERN PINE SEED BEFORE AND AFTER STORAGE. U. S. Dep. Agr. Forest Serv. Res. Note SE-15, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Stratified and unstratified seed of Pinus elliottii, P. taeda, P. echinata, *and* P. palustris *treated with 20 percent anthraquinone and 1 percent endrin (by weight) lost little germinative capacity when stored at 70-80° F. for 60, and at 38° for 370 days. Arasan-75 at 10 percent significantly reduced germination (except in* P. palustris), *but storage for 20 days at 70-80°, or up to 60 days at 38°, caused no additional reduction. To avoid damage to radicles by Arasan, the test medium should be watered before planting the seeds. FA*

Jones, L. 1967. STUDIES OF SOME FACTORS AFFECTING SURVIVAL OF WOODY PLANT SEEDLINGS. Ph.D. Thesis. Univ. Ga. Athens. Diss. Abstr. 28: 2208-B.
Longleaf pine seed was sown in tubes of polyethylene and kraft paper.

Jones, L. 1967. TUBED SEEDLINGS. Forest Farmer 26 (13): 10-11, 18.
Longleaf pine seeds were sown in kraft paper tubes filled with a mixture of perlite, soil, and peat. Eight weeks later the resulting seedlings, each still in its tube, were outplanted. Six months after planting, survival was 92 percent and roots of many seedlings had grown in excess of three feet.

Jones, L., Barber, J. C., and Mabry, J. E., Jr. 1964. EFFECT OF METHYL BROMIDE FUMIGATION ON GERMINATION OF LONGLEAF, SLASH, AND LOBLOLLY PINE SEED. J. Forest. 62: 737-739. (Abstr.) U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 55, p. 25.
Seed was fumigated at rates equaling 0.5, 1.0, and 2.0 times the dosage normally used to kill insects in seed being imported. Results indicated that slash and loblolly seed can be safely fumigated at normal dosage if their moisture content is 10 percent or below, whereas longleaf seed should be at 5-percent moisture content or below.

Lewis, C. H., Jr. 1953. A NEW APPROACH TO AN OLD PROBLEM. Forests and People 3(1): 24-26. *Also as* DIRECT SEEDING OF LONGLEAF PINE. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 1-8. 1954.
Longleaf pine is costly to plant, and survival often is poor. To avoid these difficulties, Crosby Chemical Company direct-seeded 940 acres in Louisiana during November 1952. A tractor-drawn machine seeded disked strips at the rate of 45 acres daily. Total costs approximated those of planting slash pine, and initial establishment was good.

McDermid, R. W., and Branton, D. W. 1959. REPELLENT-TREATED LONGLEAF PINE SEEDS RETAIN VIABILITY DURING 15-DAY REFRIGERATION. La. Agr. Exp. Sta. LSU Forest. Notes 33, 2 pp.
In a study of 12,800 Pinus palustris *seeds tested with 32 treatments, it was established that repellent-treated seed keep better under refrigeration (34° F.) than at air temperature. The treated seed may be kept under refrigeration for $\geq$ 15 days without loss in viability after 10 days, whether treated or not. Best results were obtained with a repellent composed of 5 percent Arasan blended with 0.5 percent endrin. It should be noted that these results were obtained by storing small amounts of seed; large quantities of stored treated seed might react differently. FA*

McLemore, B. F. 1959. CONE MATURITY AFFECTS GERMINATION OF LONGLEAF PINE SEED. J. Forest. 57: 648-650.
Samples of cones were taken at four different dates from 27 specimens of 40-year longleaf pine, and divided into specific gravity classes. Differences in mean germination percent by cone specific gravity classes were highly significant, mainly because of the much higher germination from low specific gravity cones for the first three dates of collection. Owing to the quite wide variations in the date of cone maturity between individual trees, however, the only safe way to lengthen the collecting season is to confine early efforts to trees on which the cones have a specific gravity $\leq$ 0.88. FA

McLemore, B. F. 1961. ESTIMATING PINE SEED YIELDS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 134.
Formulae for predicting yield of seeds from the number of full seeds exposed when longleaf, slash, and loblolly cones are sliced longitudinally.

McLemore, B. F. 1961. HILA OF FULL AND EMPTY LONGLEAF PINE SEEDS ARE DISTINGUISHABLE. Forest Sci. 7: 246.
Pinus palustris *seeds with distinct and indistinct hilum (cone-scale attachment-scar) are respectively full and empty. Checking by cutting test of a sorting of 1,993 seeds from 14 trees into 1,393 "full" and 600 "empty" on this basis, proved the method 97 percent correct. Among the 14 trees, reliability varied, one showing only 83 percent correct, 13 $\geq$ 95 percent, and six 100 percent correct. Seeds should have wings and, to obviate aberrant cases, seeds of individual trees should be kept separate. FA*

McLemore, B. F. 1961. PROLONGED STORAGE OF LONGLEAF CONES WEAKENS SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 132.
Viability of longleaf seed after 1 year of storage is substantially reduced if cones are kept in burlap bags for more than 30 days prior to kilning.

McLemore, B. F. 1961. STORAGE OF LONGLEAF PINE SEED. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 47, pp. 15-19.
Moisture content is more critical than temperature in storage of longleaf pine seed. Moisture contents of 10 percent or less are recommended. Temperatures from 0° to 25° are preferable to 34° F. because they provide a safety factor for seed that may have a moisture content slightly above 10 percent. Moisture content is less important when seed is stored at 0° F. Lower temperature compensates for higher moisture.

McLemore, B. F. 1962. PREDICTING SEED YIELDS OF SOUTHERN PINE CONES. J. Forest. 60: 639-641.
Develops regression equations showing the relationship of average number of sound seeds exposed in sliced cones to average total number of sound seeds per cone, for loblolly, longleaf, and slash pines. FA

McLemore, B. F. 1965. PENTANE FLOTATION FOR SEPARATING FULL AND EMPTY LONGLEAF PINE SEEDS. Forest Sci. 11: 242-243.
Full and empty seeds of Pinus palustris *Mill. can be separated with high precision by flotation in n-pentane, which is not harmful to viability. While this method is probably best suited for small lots of seed, it can also be used for large ones. Specific gravity of 0.62 at 25° C. is suitable for testing this buoyant seed. Precautions for handling the highly inflammable pentane are outlined.*

McLemore, B. F. 1967. THE INFLUENCE OF LIGHT ON GERMINATION OF LONGLEAF PINE SEED. Ph.D. Thesis. La. State Univ. Baton Rouge. Diss. Abstr. 28: 2679-B.
Seed extracted in darkness and kept in the dark failed to germinate. Seed exposed to white and red light germinated. Seed extracted in the usual manner also has light requirements for germination. Germination is inhibited by far-red light.

McReynolds, R. D. 1960. MORTALITY OF NEWLY GERMINATED SOUTHERN PINE SEEDLINGS FOLLOWING INUNDATION. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 43, pp. 23-25.
At ages of 25 days from seed, most loblolly and slash pine seedlings survived 20 days of flooding, but shortleaf and longleaf died after 12 days. Summer flooding was more damaging than spring flooding.

Maki, T. E. 1950. EFFECT OF VARYING AMOUNTS OF POTASH AND NITROGEN ON THE DEVELOPMENT AND VIGOR OF LONGLEAF PINE SEEDLINGS. (Abstr.) Assoc. Southern Agr. Workers Proc. 47: 141.
Ample potash fertilization appears requisite for vigor and survival of field-planted stock.

Mann, W. F., Jr. 1954. DIRECT SEEDING RESEARCH WITH LONGLEAF, LOBLOLLY, AND SLASH PINES. La. State Univ. Third Annu. Forest Symp. Proc. 1954: 9-18.
Discusses research by USDA Forest Service at Crossett, Arkansas, and Alexandria, Louisiana.

Mann, W. F., Jr. 1956. DIRECT-SEEDING THE SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 25, pp. 12-19. *Also in* Assoc. Southern Agr. Workers Proc. 53: 152.
Instructions for direct seeding longleaf pine.

Mann, W. F., Jr. 1957. DIRECT-SEEDING THE SOUTHERN PINES. Forest Farmer 17(2): 8-9, 12, 16-18. *Also in* Forest. Newsletter, Southeast. Sect. Soc. Amer. Forest. 13(2): 10-15. *Also in* Forest Farmer (Sixth Manual ed.) 17(7): 73-75. 1958. *Also in* (Seventh Manual ed.) 18(8): 72-75. 1959. *Also in* (Eighth Manual ed.) 19(7): 87-90. 1960. *Also in* (Ninth Manual ed.) 20(7): 58-61. 1961. *Also as* GUIDES FOR DIRECT SEEDING THE SOUTHERN PINES. Forests and People 8(3): 16-17, 44, 47-48, 51-52. 1968
Instructions for sowing longleaf, loblolly, and slash pine.

Mann, W. F., Jr. 1961. DIRECT SEEDING COMES TO THE SOUTH. Soc. Amer. Forest. Proc. 1960: 5-18.
Discovery of successful bird repellents greatly stimulated direct-seeding in the South. By 1959-1960 seeded acreage in Louisiana totaled 75,000.

Mann, W. F., Jr. 1962. HOW TO DIRECT-SEED THE SOUTHERN PINES. Forest Farmer (Tenth Manual ed.) 21(7): 52-55. *Also in* Forest World 1(2): 24-30, 32.
Instructions for seeding most of the southern pines

Mann, W. F., Jr. 1966. DIRECT SEEDING THE SOUTHERN PINES: DEVELOPMENT AND APPLICATION. Proc., Direct Seeding Workshops, Alexandria, La., and Tallahassee, Fla., pp. 2-3. U. S. Dep. Agr. Forest Serv., Atlanta, Ga.
Resumé.

Mann, W. F., Jr., and Burkhalter, H. D. 1961. THE SOUTH'S LARGEST SUCCESSFUL DIRECT-SEEDING. J. Forest. 59: 83-87.
In the winter of 1958 and spring of 1959, T. L. James and Company direct-seeded 18,545 acres of cutover longleaf pine land in central Louisiana. This is probably the largest acreage seeded successfully in the United States in a single season. Loblolly was sown by airplanes on 14,340 acres at a cost of $5.67 an acre. Stocking at the end of the first year averaged 4,451 seedlings per acre. Loblolly was furrow-seeded by machine on 1,865 acres for $3.17 an acre. First-year stocking averaged 1,070 seedlings per acre and 63 percent milacre distribution. Longleaf pine seed was broadcast on 2,360 acres at a cost of $5.82 per acre. Stocking averaged 3,610 seedlings at the end of 1 year. This large tract was regenerated at less than half the cost of planting. Moreover, capital outlay and manpower were substantially smaller and supervisory problems were simpler.

Mann, W. F., Jr., and Derr, H. J. 1954. DIRECT SEEDING OF SOUTHERN PINES. Southern Lumberman 189(2369): 115-117.
Recommendations for longleaf, slash, and loblolly pines.

Mann, W. F., Jr., and Derr, H. J. 1955. NOT FOR THE BIRDS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 20, pp. 3-6. *Also in* Forests and People 5(3): 32-33.
One of the principal hindrances to restocking longleaf pine stands by direct sowing has been the lack of a practical way of preventing birds from eating the seed. A cooperative project of the Southern Forest Experiment Station and the U. S. Fish and Wildlife Service found that the two most effective chemicals to be used as a bird-repellent seed dressing were Morkit and sublimed synthetic anthraquinone. Morkit, a mixture of anthraquinone and inert ingredients, is manufactured in Germany specifically as a bird repellent. It has no distinctive taste or odor, and the manner in which it acts to repel birds remains to be discovered. It is not known to be harmful to livestock, wildlife, or humans. Field tests with treated seed gave seedling catches of 3,000-4,000 per acre compared with 250 per acre for untreated seed. All anthraquinone compounds were good, but Morkit proved the most effective and cheapest ($0.40 per pound compared with $0.88 for sublimed synthetic anthraquinone and $2.15 for Quinizarine). Longleaf seed can be treated with Morkit for $0.15 per pound: this cost comprises all labor and materials, including an asphalt sticker. The necessary equipment can easily be made from two 55-gallon steel drums (illustrated). The method is described. FA

Mann, W. F., Jr., and Derr, H. J. 1956. DIRECT SEEDING . . . OF LONGLEAF PINE. Forest Farmer 15(6): 4-6, 18.
See Mann, 1956.

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1955. A BIRD REPELLENT FOR LONGLEAF SEEDING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 99.
Morkit, a bird repellent manufactured abroad, may make it possible to direct-seed longleaf pine at low cost and with good assurance of success.

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1956. A BIRD REPELLENT FOR DIRECT SEEDING OF LONGLEAF PINE. J. Forest. 54: 190-191.
Instructions for applying Morkit to pine seed.

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1956. BIRD REPELLENTS FOR DIRECT SEEDING LONGLEAF PINE. Forests and People 6(3): 16-17, 48.
Morkit has been withdrawn from the U. S. market, but several preparations are likely to be acceptable replacements. One of these is Arasan.

Mann, W. F., Jr., and Russell, T. E. 1956. RINGING STIMULATES LONGLEAF CONE PRODUCTION. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 103.
See entry below.

Mann, W. F., Jr., and Russell, T. E. 1957. LONGLEAF CONE PRODUCTION DOUBLED BY RINGING. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 28, pp. 6-7.
A study was begun in 1952 on open-grown Pinus palustris, *d.b.h. 6-12 inches. Ringing was done by cutting two half-circles through the cambium, on opposite sides of the bole, slightly above stump height, about 4 inches apart and overlapping by ca. 1 inch at each end. Incisions were ca. 1 inch wide and were made quickly with a bark hack of a kind used in resin tapping. Three years after treatment, the larger ringed trees produced significantly more cones than unringed (120 and 51 respectively for 12 inches, and 77 and 37 for 10 inch trees). Ringing was ineffective on trees < 10 inches, probably because they were too small to bear cones abundantly. Seed tests showed that ringing had no effect on the number of sound seeds per cone or the germinability of the seed. Strangulation and treatment with 2,4-D had no effect on cone production. FA*

Nestler, R. B. 1946. GERMINATION OF SEEDS OF SOME WILD AND CULTIVATED PLANTED AFTER 5½ YEARS OF STORAGE. J. Forest. 44: 683-684.
Seeds tested in this experiment were obtained in 1939 stored in sacks in a dry place until June 1941, at room temperature, then kept in a cold storage chamber at 32° to 33° F. until June 1943, and at 0° F. from June 1943 until July 1945. They were then returned to room temperature until autumn, when they were tested for germination and hard seeds. Of the tree species tested Pinus palustris *showed no germination. FA*

North Carolina State University School of Forestry. 1965. N. C. STATE-INDUSTRY COOPERATIVE TREE IMPROVEMENT PROGRAM. Ninth Annu. Rep., 32 pp. N. C. State Univ., Raleigh.
Reviews current progress and presents interim data on seed production studies (loblolly, Virginia, white, slash, shortleaf, pond, and longleaf pines), progeny testing, wood properties, and quantitative genetic studies, including work on tropical pines. FA

Richardson, B. Y. 1967. SHAKING TREES TO COLLECT PINE CONES. Southern Lumberman 215(2680): 140-141.
Shaking machines designed for pecan trees appear suitable for use on pines, including longleaf.

Russell, T. E. 1958. THE DIRECT SEEDING OF SOUTHERN PINES. Amer. Pulpwood Assoc. Tech. Pap. 58-P26, 8 pp.
Recommendations for longleaf, loblolly, and slash pines.

Shipman, R. D. 1955. PRELIMINARY TEST OF DIRECT LONGLEAF SEEDING. Nav. Stores Rev. 64(11): 8-9.
See entry below.

Shipman, R. D. 1955. PRELIMINARY TEST OF DIRECT SEEDING OF LONGLEAF PINE IN THE SOUTH CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 72, 2 pp.
Losses to birds and rodents of seed sown on unprotected spots were high—16 and 78 percent respectively on winter-sown and 26 and 60 percent on spring-sown plots. Even on plots protected by screen, losses to rodents were 31 and 48 percent for winter and spring sowing respectively. Critical soil moisture and temperature conditions coincided with low rainfall in May, and in 726 protected and undamaged spots 20 percent of winter-sown and 3 percent of spring-sown seed had produced established seedlings by the end of the growing season. Other less conclusive results suggested that better survival may be expected on sandy loam than on sand, and on old field sites than on scrub oak areas. Mulching seed spots with sawdust did not appreciably increase germination or survival. Further research is needed. FA

Shipman, R. D. 1963. SEEDING DEPTH—ITS INFLUENCE ON ESTABLISHMENT OF DIRECT-SEEDED PINE IN THE SOUTH CAROLINA SANDHILLS. J. Forest. 61: 907-912.
Field and greenhouse studies were undertaken to determine effects of seeding depth on the germination and establishment of longleaf and slash pines in the South Carolina sandhills. Under field conditions the recommended depth tolerance for longleaf pine was ¼ to ¾ inch, and for slash pine ½ to ¾ inch. In the greenhouse, under a controlled environment, the optimum seeding depth for longleaf was between ⅛ and ½ inch, and for slash pine between ⅛ and ¾ inch. The differences between the field and greenhouse trials can be attributed primarily to seed displacement by wind and water.

Shoulders, E. 1959. ROOT PRUNING BOOSTS LONGLEAF SURVIVAL. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 120. *Also in* U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 36, pp. 15-19.
Recommends that pruning be done at a depth of approximately 7 inches and 2 or 3 months before the seedlings are lifted from the nursery bed.

Shoulders, E. 1960. CAUTION NEEDED IN FALL APPLICATIONS OF NITROGEN TO NURSERY STOCK. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 38, pp. 25-27.
Late-season fertilization of nursery beds with heavy application of N is sometimes recommended to improve field survival of southern pine seedlings. A study in 1956 and 1957 by the Southern Forest Experiment Station showed, however, that though the practice is helpful in some circumstances (e. g., when there is a known nutrient deficiency) it must be used with great caution, since it can sometimes reduce survival (especially of longleaf pine) and height growth. FA

Shoulders, E. 1963. ROOT-PRUNING SOUTHERN PINES IN THE NURSERY. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-5, 6 pp. Southern Forest Exp. Sta., New Orleans, La.
In Louisiana, root pruning in the nursery bed usually improves field survival of longleaf pine and sometimes of loblolly and slash pine. Growth of large seedlings is retarded by pruning in August and September, but yields of plantable stock may not be greatly increased thereby, because reductions in oversize seedlings may be offset by increases in undersize stock.

Shoulders, E. 1965. ROOT PRUNING IN SOUTHERN PINE NURSERIES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 70, pp. 12-15.
See entry below.

Shoulders, E. 1967. FERTILIZER APPLICATION, INHERENT FRUITFULNESS, AND RAINFALL AFFECT FLOWERING OF LONGLEAF PINE. Forest Sci. 13: 376-383.
Production of female strobili in heavily thinned and cultivated stands was influenced, in descending order of importance by (1) inherent ability to flower, (2) spring and early summer rainfall in year of flower bud formation, (3) annual rate of fertilizer application, and (4) flowering 2 years earlier.

Shoulders, E. 1967. LONGLEAF FIELD PERFORMANCE UNIMPAIRED BY NURSERY CLIPPING TO FACILITATE BROWN-SPOT

CONTROL. U. S. Dep. Agr. Forest Serv. Res. Note SO-60, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Neither field survival and growth nor size and grade of nursery stock were adversely affected when the needles of spring-sown seedlings were clipped to a length of 6 inches in late summer or immediately before lifting.

Silker, T. H., and Goddard, R. E. 1953. DIRECT SEEDING TESTS WITH SLASH, LOBLOLLY, AND LONGLEAF PINE IN SOUTHEAST TEXAS. Tex. Forest Serv. Tech. Rep. 7, 36 pp.
Spot seeding appeared better than broadcast seeding. Pelleted seed gave average germination 60 percent below that of untreated seed. Stocking from broadcast sowing was better for slash pine than for loblolly.

Snyder, E. B., and Squillace, A. E. 1966. CONE AND SEED YIELDS FROM CONTROLLED BREEDING OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-22, 7 pp. Southern Forest Exp. Sta., New Orleans, La.
Over a 10-year period, survivals of cones from controlled cross-pollinations were less than 40 percent, and seed yields per cone averaged about half those from wind-pollinations. Self-pollinations produced about 15 percent as much seed as cross-pollinations. Interspecific pollinations were generally less productive than intraspecific pollinations.

Swofford, T. F. 1960. THE EFFECT OF AIR DRYING OF CONES UPON SEED GERMINATION. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 43, pp. 3-4.
Cones were collected from Pinus elliottii, P. taeda, *and* P. palustris *in Florida, and in each case half of the cones (a) collected from each tree were placed in the usual well ventilated but unheated drying sheds, and half (b) were sent to the Tree Seed Testing Laboratory at Macon, Georgia, and placed in wire baskets in an air-conditioned room maintained at 72° C. Cones in lot (b) opened in 4 days and the seeds were immediately tested for germination; cones in lot (a) had opened at the end of 6 weeks and the seed was sent to the laboratory for testing. Germination percent of* P. elliottii *was not significantly different in (a) and (b), but in* P. taeda *and* P. palustris *it was considerably higher in (b) (90 and 67 respectively vs. 71 and 57). FA*

USDA Forest Service. 1948. WOODY-PLANT SEED MANUAL, pp. 262, 391, 393. U. S. Dep. Agr. Misc. Pub. 654.
Statistics useful in collecting, extracting, storing, testing, treating, and sowing longleaf seed.

Wakeley, P. C. 1948. COLLECTING SOUTHERN PINE SEED. Forest Farmer 7(12): 1, 7. *Also in* AT-FA J. 11(1): 9, 16.
Instructions for collecting cones and extracting seed.

Wakeley, P. C. 1949. PHYSIOLOGICAL GRADES OF SOUTHERN PINE NURSERY STOCK. Soc. Amer. Forest. Proc. 1948: 311-322.
The grading rules generally used for classifying 1-0 planting stock of slash and longleaf pine are based on foliage, bud and bark development, and seedling size. It is shown that these morphological characters may be quite misleading, and the existence of physiological grades, based on ability to make new root growth and maintain water intake, is put forward. The possibility of (a) recognizing such grades, and (b) modifying them by special nutrition, differences in water tension under which seedlings are grown, and application of sprays, protective coatings, etc., at lifting time are discussed. FA

Wakeley, P. C. 1951. STORING SOUTHERN PINE SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 123, 13 pp.
Gives directions for cold storage of seed at not above 41° F. and preferably between 5 and 32°, at a constant moisture content of between 6 and 9 percent for longleaf and 9 and 12 percent for other southern pines, with special recommendations for storage longer than one winter, and for shipping seed abroad. FA

Wells, D. W., and Reines, M. 1965. VEGETATIVE PROPAGATION OF NEEDLE BUNDLES OF PINES. Ga. Forest Res. Counc. Res. Pap. 26, 8 pp.
Rooting ability of longleaf needle bundles was high without chemical treatment. Chemicals improved the rooting ability of loblolly and slash pine bundles.

232.4 PLANTING

Allen, R. M. 1951. CLIPPING AND DIPPING REDUCE LONGLEAF MORTALITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 71.
Clipping the needles and dipping the tops in lanolin or wax reduced mortality of longleaf pine seedlings to 17 percent (1/3 of needle length removed) or 13 percent (2/3 of needle length removed) compared with 81 percent for controls. Dipping in wax without clipping gave 18 percent mortality. FA

Allen, R. M. 1953. CLIPPED LONGLEAF. Southern Lumberman 187 (2345): 140.
In three years of trials on a wide variety of sites, clipping the needles to 5 inches before planting the seedlings increased survival by 10 to 30 percent.

Allen, R. M. 1953. LARGE LONGLEAF SEEDLINGS SURVIVE WELL. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 14, pp. 17-18.
In a test of machine planting, large longleaf seedlings (which are easy to plant by machine but reputed to survive poorly) performed about as well as stock of small or medium size.

Allen, R. M. 1953. SURVIVAL OF MACHINE-PLANTED VS. BAR PLANTED LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 14, pp. 16-17.
In a 1947 test survival after the second year in the field was 64 percent for machine planting and 71 percent for bar planting. In a 1948 test it was 44 percent for machine planting and 52 percent for bar planting. Differences between the two methods were not statistically significant.

Allen, R. M. 1954. INCREASING THE SURVIVAL OF PLANTED LONGLEAF PINE SEEDLINGS. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 64-65.
Clipping needles to 5 inches increases survival more than does application of wax foliage coatings.

Allen, R. M. 1954. SHADE MAY IMPROVE LONGLEAF SURVIVAL. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 90. *Also in* The Unit, News Letter 54, p. 6. *Also in* Forests and People 4(3): 31.
On a sandy site in south Mississippi artificial shade provided with palmetto fronds improved survival of planted seedlings. At the end of the first growing season survival was 27 percent for unshaded and 83 percent for shaded seedlings.

Allen, R. M. 1955. FOLIAGE TREATMENTS IMPROVE SURVIVAL OF LONGLEAF PINE PLANTINGS. J. Forest. 53: 724-727.
Recommends the clipping of planting-stock foliage to 5 inches near the time of lifting. Wax foliage coatings (in this case Dowax, a compound of paraffin wax, lentonite, and NH_4 linoleate) require further trials. Reducing the storage period increases field survival. FA

Allen, R. M. 1955. GROWTH OF PLANTED LONGLEAF PINE ON CUTOVER LAND AND OLD FIELDS. J. Forest. 53: 587.
During a 10-year period, planted seedlings grew better on abandoned fields than on cutover forest land, but sur-

vival was about the same. Slower growth on cutover land was probably due to more intense brush and grass competition.

Allen, R. M., and Maki, T. E. 1951. FOLIAGE TREATMENTS REDUCE EARLY MORTALITY OF LONGLEAF PINE PLANTED ON ADVERSE SITES. J. Forest. 49: 115.
Clipping and dipping needles significantly increased survival of 1-0 stock planted on an adverse site. Removal of two-thirds of the needles was better than removal of one-third; a combination of clipping and dipping in a Dowax or lanolin coating gave best results.

Allen, R. M., and Maki, T. E. 1955. RESPONSE OF LONGLEAF PINE SEEDLINGS TO SOILS AND FERTILIZERS. Soil Sci. 79: 359-362.
Pinus palustris *is unique in that active height growth does not begin until ground-line stem diameter is ca. 1 inch, i. e., at 5 to > 7 years, depending on site factors. Thus the tallest 12-year pines on eroded and noneroded sandy loam plots were 0.8 and 14.6 feet respectively. Seedlings were sown in pots of three different soils and treated with no fertilizer, N, and NPK. At 12 months they were lifted for weighing, root pruned and transplanted into a sandy soil in a greenhouse for observation on transplanting survival and a drought test. Watering was done for the first 48 days, then withheld until the transplants were parched, and then resumed. Results (tabulated) show that seedlings differ in green weight and ability to survive transplanting with the media in which they are raised. The mean green weight of seedlings was doubled by NPK as compared with the means for N and for no fertilizer. FA*

Bumgarner, G. 1967. SUMMER PLANTING IN THE SOUTHEASTERN UNITED STATES. Amer. Pulpwood Assoc. Tech. Pap. (Jan.): 21-22.
Reports successful mechanical planting of Pinus elliottii *seedlings (age ≥ 7 months) in north Florida and June-September, subject to careful handling, storage, and site preparation. Summer planting of* P. palustris *and* P. clausa *failed. FA*

Derr, H. J. 1948. KEEP LATERAL ROOTS ON LONGLEAF PLANTING STOCK. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 54.
In January 1941, 200 longleaf seedlings, half with lateral roots nearly intact and half with them broken off in lifting, were planted in alternate 10-tree rows in central Louisiana. In July 1947 survival was 58 percent for seedlings with laterals, 20 percent for those without. Seedlings with laterals made better height growth.

Derr, H. J. 1955. BED DENSITY AFFECTS LONGLEAF VIGOR. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 97.
See entry below.

Derr, H. J. 1955. SEEDBED DENSITY AFFECTS LONGLEAF PINE SURVIVAL AND GROWTH. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 20, pp. 28-29.
Reducing nursery seedbed density from 30 to 10 seedlings per square foot improved survival and first-year growth of outplanted longleaf in Louisiana.

Derr, H. J. 1957. EFFECTS OF SITE TREATMENT, FERTILIZATION, AND BROWN SPOT CONTROL ON PLANTED LONGLEAF PINE. J. Forest. 55: 364-367.
In central Louisiana, burning, furrowing, or disking a 5-year-old grass rough had little effect on survival or early growth of planted longleaf pine. Spraying the seedlings with bordeaux mixture controlled the brown-spot needle blight and thereby enabled more than 75 percent of the surviving stand to start height growth in the fourth and fifth years. Fertilizing seedlings at planting time depressed growth by stimulating competing grasses except on furrowed strips where the grasses were completely eliminated.

Derr, H. J. 1963. NEEDLE CLIPPING RETARDS GROWTH OF PLANTED LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 57, pp. 31-33.
Clipping the needles of Pinus palustris *seedlings immediately before planting reduced vigor and rate of early growth in three tests in central Louisiana. Survival was unaffected in two tests but was reduced in the third when seedlings encountered an early summer drought. FA*

Fassnacht, D. L. 1955. BAR-SLIT GOOD FOR SANDHILL HAND PLANTING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 95.
In west Florida, longleaf and slash pine seedlings planted in slits made with a planting bar survived as well as those planted by hand in holes made with a post-hole digger.

Garin, G. I., and Livingston, K. W. 1950. SURVIVAL AND GROWTH OF PLANTED SLASH AND LONGLEAF PINES. Ala. Agr. Exp. Sta. Circ. 97, 15 pp.
A 12-year study in south Alabama determined survival and growth of pines planted on furrowed and burned sites. Longleaf survived better on sites unburned before planting. Later burning improved growth. Initial survival was best on furrowed areas but differences were not significant after 3 years. Height growth of longleaf was less on sod than in furrows. Slash pine survived better and grew faster than longleaf.

Hatcher, J. B. 1957. PRESCRIPTION PLANTING. Forest Farmer 16(5): 4-6.
Prescription planting, i. e., the allocation of specific grades of stock to specific sites, markedly improves survival of longleaf and slash pine on the Savannah River Project of the Atomic Energy Commission, in South Carolina. Prescriptions for sandhill sites are given.

Hodges, C. S. 1961. FREEZING LOWERS SURVIVAL OF THREE SPECIES OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 47, pp. 23-24.
When bundled seedlings of longleaf, loblolly, and slash pine were exposed to 20° F. for varying periods, survival of planted seedlings was virtually nil after 48 hours exposure. Loblolly showed hardly any, and slash pine little reduction in survival after 24 hours, but survival of longleaf, which was only 45 percent in controls, fell to 28 percent after 6, and 2 percent after 24 hours. FA

Jones, L. 1967. TUBED SEEDLINGS. Forest Farmer 26(13): 10-12.
A new planting technique for longleaf pine and other forest trees.

Kinne, S. B., Jr. 1954. REGENERATION OF SLASH AND LONGLEAF PINE. Ind. Forest Manage. Conf. Proc. 1954: 10-14.
Enumerates problems encountered by a large industrial company in regenerating slash and longleaf pine in south Georgia and north Florida. Mentions controlled burning, establishment of seed-production areas, planting, direct seeding, and natural regeneration.

Lotti, T., and Shipman, R. D. 1957. RETURN OF LONGLEAF TO THE SANDHILLS. Forest Farmer 16(4): 14-15.
It is planned to reforest 3 million acres of the Carolina-Georgia sandhill region with longleaf pine. Experience in South Carolina indicates that competing scrub oaks should be deadened not later than the third season after pines are planted.

Lyle, E. S., Jr., Gilmore, A. R., and May, J. T. 1958. SURVIVAL AND GROWTH OF 2-0 LONGLEAF AND LOBLOLLY SEEDLINGS IN THE FIELD. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 33, pp. 26-27.
In both species, 2-0 stock gave poorer survival but slightly better height growth than did 1-0 stock. Root pruning did not affect growth.

McGee, C. E. 1961. AGE OF STOCK AS A FACTOR IN SURVIVAL AND GROWTH OF LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 158, 2 pp.
As earlier studies had stressed the importance of large and vigorous planting stock for sandhill afforestation, 1-0, 1-1, and 2-0 stock were compared on two deep-sand sites in South Carolina. Both first- and fifth-year survival were best for the 1-0 stock, and its height growth was better than that of the 2-0 and little less than the 1-1. FA

McGee, C. E., and Scott, H. R. 1965. PLANTING LONGLEAF PINE IN THE CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 70, pp. 4-5.
Study reaffirms that dipping longleaf foliage improves survival, and that it is highly desirable from the growth standpoint to plant Grade 1 seedlings. Root pruning to 3 inches is not recommended, but more moderate pruning shows no significant reduction in survival or growth. Recommended practices are: allow at least 90 days between site preparation and planting, and plant after the period when hard freezes are expected.

Muntz, H. H. 1948. GOOD SURVIVAL FROM MACHINE-PLANTED PINES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 57. *Also in* Nav. Stores Rev. 58(28): 6. *Also in* Southern Lumberman 177(2225): 178. *Also in* Nav. Stores Rev. 58(46): 2. 1949.
In a test in central Louisiana, first-year longleaf survival was 86 percent for machine-planted trees and 89 percent for trees planted by hand.

Scarbrough, N. M., and Allen, R. M. 1954. BETTER LONGLEAF SEEDLINGS FROM LOW-DENSITY NURSERY BEDS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 18, pp. 29-32.
In tests in south Mississippi, in which beds were sown in March and thinned to densities of 12, 24, 36, or 48 seedlings per square foot in May, planting stock from nursery beds with not more than about 24 seedlings per square foot was larger at lifting time (December), survived better in the field, and began height growth sooner than seedlings from denser beds. FA

Shipman, R. D. 1958. PLANTING PINE IN THE CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 96, 43 pp.
A paper based on published and unpublished research and experience on many experimental sites, dealing chiefly with the establishment of Pinus palustris, *the original pine of the area, thought to be best in the long run, despite better survival and early growth of* P. elliottii, P. taeda, *and other species, e.g.,* Juniperus virginiana. *Seed source, nursery treatment, site preparation, planting, and early tending are discussed. Prescriptions are given for the spacing of seedlings of various grades for various soils and soil preparation to produce a given plant percent. Chief recommendations are to plant (by machine for preference) 1 + 0 high-grade seedlings root-pruned and with foliage clipped, in winter, on scrub oak sites after complete clearing or furrowing and on old fields after furrowing, plus chemical control of competing vegetation. FA*

Shipman, R. D. 1960. SURVIVAL AND GROWTH OF GRADED LONGLEAF PINE NURSERY STOCK. J. Forest. 58: 38-39, 42.
Seedlings of Pinus palustris *totalling 2,400 were divided into two grades by stem size and general appearance and planted in plots on Carolina-Georgia sandhills. Best survival (66-76 percent) resulted from planting grade-1 seedlings on sand or sandy loam, regardless of date in the dormant season. Since grade 2 failed on sand or when planted late, most effective use of stock was to plant both grades on sandy loam in mid-dormant season. On average, grade-1 seedlings maintained a 1.9 foot height advantage over grade 2; after five growing seasons 40 percent of grade 1 were > 7 feet high vs. 16 percent for grade 2. Clipping foliage had little or no effect on survival. FA*

Slocum, G. K., and Maki, T. E. 1959. EXPOSURE OF LONGLEAF PINE PLANTING STOCK. J. Forest. 57: 825-827.
One-year-old seedlings were exposed to direct sunlight for periods of 0-180 minutes. Temperature averaged 73-80° F. Half of the 1,040 test seedlings had bare roots, the other half had roots covered with creamy clay mud before exposure. All seedlings were then planted and mortality was recorded throughout the first growing season. Seedlings with roots protected by the clay slurry suffered negligible damage from exposure up to ¾ hour. Even after 3 hours of direct exposure, more than half of the large seedlings with clay-puddled roots survived. Large seedlings (¼-inch rootcollar diameter) withstood exposure approximately 65 percent better than small seedlings (5/32-inch rootcollar diameter).

Slocum, G. K., and Maki, T. E. 1960. EFFECTS OF DESICCATION ON PUDDLED VERSUS BARE-ROOTED LOBLOLLY PINE AND LONGLEAF PINE PLANTING STOCK. J. Forest. 58: 528-531.
Longleaf and loblolly pine planting stock (a) *bare-rooted and* (b) *with mud-coated roots, were subjected to desiccation in an unheated shed for 1½, 3, 6, or 12 days, after which they were planted in replicated randomized plots in the nursery. At the end of the first growing season it was found that survival of longleaf* (b) *stock averaged 94.8 percent, and of loblolly 100 percent vs. 80.4 and 92.8 percent respectively for* (a). *Duration of desiccation up to 12 days had no effect on* (b); *but for* (a), *survival of longleaf dropped to 74 percent after 6 days and 50 percent after 12 days. Loblolly* (a) *stock held up well through the sixth day (98 percent survival) but by the 12th day had dropped to 66 percent. Shoot growth of loblolly* (b) *stock [not measured on longleaf] was unaffected by duration of desiccation, but with* (a), *12 days of desiccation reduced current shoot growth 29 percent below* (b). *FA*

Smith, L. F., Snyder, E. B., and Scarbrough, N. M. 1963. CARE OF PINE SEEDLINGS USED IN BREEDING AT INSTITUTE OF FOREST GENETICS. U. S. Dep. Agr. Forest Serv. Res. Note SO-2, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Describes methods developed for longleaf pine in Mississippi, giving 95-97 percent survival and improved growth. The essentials are: transplanting nursery stock to pots for a few months before planting out, clean cultivation of plantations, and control of insects and diseases. FA

Smith, M. B., Jr. 1954. LONGLEAF PINE SEEDLING SURVIVAL AFFECTED BY DEPTH OF PLANTING. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 17, pp. 13-14.
Preliminary results of experiments indicate that Pinus palustris *seedlings should be planted with the root collar at, or within ½ inch below, ground level. FA*

Wakeley, P. C. 1954. PLANTING THE SOUTHERN PINES. U. S. Dep. Agr., Agr. Monogr. 18, 233 pp.
Comprehensive discussion of planting policies; collection, extraction, storage, testing, and treatment of seed; nursery practice; planting practices, and plantation management

Ware, L. M., and Stahelin, R. 1946. HOW FAR APART SHOULD PINES BE PLANTED? Southern Lumberman 173 (2177): 191-193.
See entry below.

Ware, L. M., and Stahelin, R. 1948. GROWTH OF SOUTHERN PINE PLANTATIONS AT VARIOUS SPACINGS. J. Forest. 46: 267-274.
Reports yields from slash, longleaf, and loblolly plantations at spacings ranging from 4 by 4 to 16 by 16 feet. Apparently longleaf should be planted closer than slash or loblolly.

Woods, F. W., Hebb, E. A., and Fassnacht, D. L. 1956. MULCH NOT BENEFICIAL TO SEEDLINGS ON DEEP SANDS. J. Forest. 54: 595.
In western Florida, a mulch of longleaf pine needles did not increase the survival of pines planted in the sandhills, and seems to have promoted excessive temperatures around the young stems.

24 TENDING OF STANDS AND TREES: IMPROVEMENT, THINNING, PRUNING

Brasington, J. J. 1948. PULL—CUT—OR POISON? Forest Farmer 7(5): 14.
Three mthods of eradicating scrub oaks from longleaf pine sites were tested: pulling with a crawler tractor, cutting with axes, and treating with a chemical. The chemical method was best. Pulling was too expensive, and felling induced sprouting.

Bruce, D. 1954. HOW EARLY CAN LONGLEAF BE PRUNED? U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes. 91.
Sapling longleaf pines can be pruned to half their height without loss of growth. Heavier pruning will reduce diameter growth. Small saplings can withstand more severe pruning than large ones, because they carry a greater proportion of their needles on the bole.

Bull, H. 1950. POINTERS ON THINNING SOUTHERN PINES. Southern Lumberman 181(2273): 259-260.
General rules for all southern pines, including longleaf.

Chapman, H. H. 1951. EFFECT OF THINNING UPON YIELDS OF SECOND-GROWTH LONGLEAF PINE ON SITE 80 IN LA SALLE PARISH, LA. J. Forest. 49: 578-579.
A study in a well-stocked stand (on a site with an index of 80) indicated that thinning should be delayed until the trees are 25 to 30 years old. A heavy thinning should then be made, to remove half of the crown canopy.

Chapman, H. H. 1953. EFFECTS OF THINNING ON YIELDS OF FOREST GROWN LONGLEAF AND LOBLOLLY PINES AT URANIA, LA. J. Forest. 51: 16-26.
Early thinning (before age 25) reduced the total yields of longleaf pine. Longleaf yielded slightly more cordwood than loblolly at age 36. The financial aspects of a loblolly invasion of longleaf sites are discussed.

Derr, H. J., and Mann, W. F., Jr. 1953. COST OF PRUNING LONGLEAF PINE. J. Forest. 51: 579-580.
From experience in central Louisiana, pruning appears most practical on trees 4 to 6 inches in d.b.h. Longleaf trees of this size will exceed 30 feet in total height. They can be pruned to 17 feet in a single operation and will still retain more than 40 percent of their live crown.

Evans, T. C., and Gruschow, G. F. 1954. A THINNING STUDY IN FLATWOODS LONGLEAF PINE. J. Forest. 52: 9-10.
Data from 22 plots on longleaf pine soils in the Osceola and Olustee forests bear out experience elsewhere that maximum volume production of this species is obtainable over a wide range of stand density. They further suggest that fairly light densities favor vertical and lateral crown development and the production of resin or forage with less loss in volume production, than is generally supposed. FA

Farrar, R. M., Jr. 1961. AERIAL APPLICATION OF FOUR SILVICIDES IN SOUTH ALABAMA. Southern Weed Conf. Proc. 14: 198-201.
The butoxy ethanol ester of 2,4,5-T proved superior to three newer formulations for controlling scrub oaks with minumum damage to longleaf pine seedlings. Chemicals were applied at 2 pounds acid equivalent per acre.

Gaines, E. M. 1951. A LONGLEAF PINE THINNING STUDY. J. Forest. 49: 790-792.
Results of a 15-year study in southern Alabama suggest that 22-year-old longleaf stands should be thinned to 500 to 900 trees per acre. In very dense young stands (2,300 trees per acre) precommercial thinning may be desirable.

Gaines, E. M. 1951. GROWTH AFTER THINNING YOUNG LONGLEAF PINE. Southern Lumberman 183(2297): 168-170.
See entry above.

Hawley, N. R. 1953. MERCHANTABLE HEIGHT GREATER AFTER IMPROVEMENT CUT IN PILOT-PLANT MANAGEMENT TEST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 33, 2 pp.
An improvement felling removing only 18 percent (four stems per acre) from young loblolly-slash pine sawtimber stands was shown by successive inventories on 1,471 acres to increase average merchantable height in the larger diameter classes of reserved trees by up to 2½ feet, or 16 percent of one standard 16-foot log, and to increase average board-foot volumes by about 10 percent. Results are shown in graphs. FA

Malac, B. F., and Johnson, J. W. 1955. COOK TRACT THINNING STUDY, SLASH-LONGLEAF PINE STANDS. Union Bag Pap. Corp. Woodland Res. Note 1, 2 pp.
Results for the first 5 years of a study on thinning treatments in a 20-year-old mixed stand. An improvement thinning gave highest total volume production over the period; thinning from below gave greatest increase in basal-area increment. FA

Russell, T. E., and Derr, H. J. 1956. LONGLEAF HEIGHT UNAFFECTED BY STAND DENSITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 101. *Also in* The Unit, News Letter 62, p. 6.
At age 20 years, pines in a plantation averaging 404 trees per acre were as tall as those in lighter stands.

Shoulders, E. 1967. GROWTH OF SLASH AND LONGLEAF PINES AFTER CULTIVATION, FERTILIZATION, AND THINNING. U. S. Dep. Agr. Forest Serv. Res. Note SO-59, 3 pp.
Volume growth of pulpwood and saw-log size trees was decreased by disking and heavy thinning and increased by fertilization. Diameter growth was increased by fertilization and heavy thinning but decreased by disking.

Smith, L. F. 1955. DEVELOPMENT OF SECOND-GROWTH LONGLEAF PINE IN SOUTH MISSISSIPPI. J. Forest. 53: 648-649.
Gives data at more or less 5-year intervals (13th to 42nd year) of stem number, mean d.b.h., basal area, and cords per acre for that part of the stand $\geq$ 3.5 inches d.b.h., with a table of increment and mortality. Longleaf pine should be thinned at 25 years to 400 stems per acre, and thereafter at 5- to 10-year intervals. Here thinnings were delayed until the 36th year; production averaged one cord per acre per year. The site index was 80 feet in 50 years. FA

26 COMBINATIONS OF FORESTRY AND AGRICULTURE: GRAZING

Bond, W. E., and Campbell, R. S. 1951. PLANTED PINES AND CATTLE GRAZING—A PROFITABLE USE OF SOUTHWEST LOUISIANA'S CUT-OVER PINE LAND. La. Forest. Comm. Bull. 4, 28 pp.
Discusses economic aspects of combining cattle grazing with pine plantation management.

Brasington, J. J. 1948. CATTLE GRAZING IN SOUTH ALABAMA AND WEST FLORIDA FORESTS. Southern Lumberman 177 (2225): 183-186.
Most of the 400,000 cattle in the Coastal Plain of south Alabama and west Florida get all or part of their food from forest range. There are numerous conflicts between timber and cattle management. Results of a survey of woods grazing are presented for six areas: the longleaf pine hills, flatwoods, loblolly pine-hardwood hills, wiregrass, longleaf-shortleaf-loblolly, and Mobile river bottoms.

Brasington, J. J. 1949. FOREST GRAZING IN SOUTH ALABAMA AND WEST FLORIDA. Forest Farmer 9(3): 8.
See entry above.

Campbell, R. S. 1944. GRAZING CATTLE ON SOUTHERN PINE FORESTS. Southern Lumberman 169(2129): 188-191.
Interviews with 118 farmers grazing cattle on forest range showed that cattle do little damage to pine seedlings when ranges are moderately stocked. Grazing reduces the fire hazard by 27 percent. Opinion was almost unanimous that indiscriminate burning damages both trees and forage, but that prescribed burning in the longleaf pine type improves grazing and reduces fire hazard. Farmers estimated an average reduction of 2.5 percent a year in grazing capacity as the canopy of a fully stocked stand closes over.

Campbell, R. S. 1946. DETERMINATION OF GRAZING VALUES OF NATIVE VEGETATION ON SOUTHERN PINE FOREST RANGES. Ecology 27: 195-204.
In central Louisiana, studies in 1944 and 1945 showed approximately 1,389 pounds of green herbage per acre (air-dry) on open grassland, 745 pounds in an oak type, and 626 pounds in an old-growth pine type, on unburned range in July. Production was about double this amount by October, but was less palatable and nutritious. Production on burned range in July was about one-third less but was considerably more available and edible. Nutritive values were far below maintenance for cattle in winter but were adequate for good gains during March and April, with 11 to 13 percent protein and a satisfactory mineral content. Values were sufficient for animal maintenance through summer and early fall. Development of a practical management system on southern pine forest ranges means making the most of relatively high forage values in spring and early summer. Then such ranges should be supplemented by other sources of forage and feed.

Campbell, R. S. 1955. INTEGRATION OF GRAZING AND TIMBER PRODUCTION IN THE DEEP SOUTH. Soc. Amer. Forest. Proc. 1954: 199-201.
Cattle grazing promises to continue as a permanent use of forest land in the longleaf-slash pine belt. If properly managed, cattle will do little damage to pine regeneration, and they will utilize grass and other forage that might otherwise feed wildfires.

Campbell, R. S., and Cassady, J. T. 1951. GRAZING VALUES FOR CATTLE ON PINE FOREST RANGES IN LOUISIANA. La. Agr. Exp. Sta. Bull. 452, 31 pp.
Kind, amount, and nutritive value of forage are described. Weight gains and losses of range cattle are related to forage values and improved cattle management practices are discussed.

Cassady, J. T. 1949. UTILIZING FORAGE ON LONGLEAF PINE FOREST RANGES. Pap. presented at Assoc. Southern Agr. Workers, Forest. Sect. Symp. 10 pp. Baton Rouge, La.
Herbaceous vegetation in the longleaf-slash pine belt may be classed under two subtypes: wiregrass and bluestem.

Cassady, J. T. 1949. UTILIZING FORAGE ON SOUTHERN FOREST RANGE. Assoc. Southern Agr. Workers Proc. 46: 103-104.
See entry above.

Cassady, J. T. 1955. GRAZING ON FOREST LAND. Forest Farmer Manual. Ed. 3, pp. 144-146. *Also in* Ed. 4, pp. 144-146. 1956. *Also in* Ed. 5, pp. 128-129. 1957. *Also in* (Sixth Manual ed.) 17(7): 132-133. 1958. *Also in* (Seventh Manual ed.) 18(8): 126-127. 1959.
Properly managed herds will cause essentially no damage to the timber or watershed. Generally, forest grazing should be limited to the Coastal Plain, especially the longleaf-slash pine belt.

Cassady, J. T., and Campbell, R. S. 1951. PINE FOREST RANGES IN LOUISIANA. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 7 pp.
Describes pine forest ranges of Louisiana and estimates average forage production and carrying capacity.

Duncan, D. A., and Epps, E. A., Jr. 1958. MINOR MINERAL ELEMENTS AND OTHER NUTRIENTS ON FOREST RANGES IN CENTRAL LOUISIANA. La. Agr. Exp. Sta. Bull. 516, 19 pp.
Longleaf pine-bluestem native forest ranges in central Louisiana seem to contain ample trace minerals for cattle nutrition. Of major nutrients, potassium is abundant and calcium is adequate, but phosphorus is deficient at all seasons and crude protein is seriously lacking except in spring and early summer.

Duvall, V. L. 1966. REACTIONS OF LONGLEAF PINE-BLUESTEM RANGE TO GRAZING AND BURNING. Proc., IX Int. Grassland Congr., pp. 1339-1343.
In a 12-year test in Louisiana, grazed range yielded 465 pounds more dry grass per acre annually than ungrazed. Yearly grass production was unaffected by prescribed burns at intervals of 4 or 5 years.

Duvall, V. L., and Linnartz, N. E. 1967. INFLUENCES OF GRAZING AND FIRE ON VEGETATION AND SOIL OF LONGLEAF PINE-BLUESTEM RANGE. J. Range Manage. 20: 241-247.
Herbage yield and density of cover were greater on moderately or heavily grazed than on ungrazed range. Botanical composition remained relatively constant under moderate use but changed markedly on ungrazed and heavily grazed ranges. Grazing compacted soils, but insufficiently to impair herbage growth or accelerate erosion. Fire had little long-range effect.

Duvall, V. L., and Whitaker, L. B. 1963. SUPPLEMENTAL FEEDING INCREASES BEEF PRODUCTION ON BLUESTEM-LONGLEAF PINE RANGES. La. Agr. Exp. Sta. Bull. 564, 18 pp.
A 5-year study in central Louisiana showed that cottonseed cake supplied in moderate amounts from October until May, salt and steamed bonemeal furnished free-choice yearlong, and a small amount of hay fed in late winter permit efficient, profitable beef production on forest ranges.

Grelen, H. E. 1967. COMPARISON OF CAGE METHODS FOR DETERMINING UTILIZATION ON PINE-BLUESTEM RANGE. J. Range Manage. 20: 94-96.
Plucking herbage from caged quadrats to stimulate grazing resulted in lower estimates of yield and utilization than did monthly or yearly clipping of herbage from caged and open quadrats. At the end of the grazing season, estimates of

ungrazed herbage did not differ significantly by measurement technique.

Grelen, H. E., and Epps, E. A., Jr. 1967. HERBAGE RESPONSES TO FIRE AND LITTER REMOVAL ON SOUTHERN BLUESTEM RANGE. J. Range Manage. 20: 403-404.
Yield and nutrient content on burned plots differed little from that on plots that were closely mowed and raked. Thus the benefits of burning were attributed mainly to litter removal.

Grelen, H. E., and Epps, E. A., Jr. 1967. SEASON OF BURNING AFFECTS HERBAGE QUALITY AND YIELD ON PINE-BLUESTEM RANGE. J. Range Manage. 20: 31-33.
Burning different portions of a range in winter, spring, and summer provided adequate protein in herbage for a much longer period than winter burning alone. Phosphorus was deficient the year around regardless of burning schedule.

Halls, L. K. 1955. GRASS PRODUCTION UNDER DENSE LONGLEAF-SLASH PINE CANOPIES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 83, 2 pp.
In the wiregrass type of south Georgia, normal grass production of 1,000 pounds per acre (ovendry) on open forest ranges declined consistently as tree canopy increased from 5 to 35 percent but tended to level off at about 300 pounds per acre under canopies of 35 to 50 percent.

Halls, L. K. 1959. COORDINATION OF CATTLE GRAZING AND TIMBER GROWING ON SOUTHERN COASTAL PLAIN FORESTS. Soc. Amer. Forest. Proc. 1958: 192-195.
Longleaf and slash pine forests can grow livestock and timber at the same time, and thus contribute more to the economy than if managed for a single product. Compatible dual-use requires minimizing grazing damage to young pines, securing proper seasonal distribution of cattle, providing an adequate year-round grazing and feeding program, periodically burning the rough to reduce fire hazard and promote growth of higher quality forage, regulating timber stand density to insure healthy growth of trees and reasonable forage production, and controlling undesirable plants that compete with timber and forage.

Halls, L. K. 1966. FORAGE AND CATTLE PRODUCTION IN LONGLEAF SLASH PINE FORESTS. Proc., IX Int. Grassland Congr., pp. 1609-1612.
Requisites for success include feeding supplements to compensate for deficiencies in the range forage; selecting Brahman-cross cows; increasing forage quality and quantity through prescribed burning and controlling tree density; grazing at proper intensity; and regulating cattle distribution, numbers, and season of grazing, so as to prevent damage to the trees.

Halls, L. K., Hale, O. M., and Knox, F. E. 1957. SEASONAL VARIATION IN GRAZING USE, NUTRITIVE CONTENT, AND DIGESTIBILITY OF WIREGRASS FORAGE. Ga. Agr. Exp. Sta. Tech. Bull. N. S. 11, 28 pp.
Wiregrass forage in longleaf-slash pine forests in the Lower Coastal Plain of Georgia had highest digestion coefficients for cattle in the spring. Digestibility did not decrease greatly between April through September but dropped perceptibly by December. Weight changes in cattle emphasized the nutrient limitations of the native forage.

Halls, L. K., Hale, O. M., and Southwell, B. L. 1956. GRAZING CAPACITY OF WIREGRASS-PINE RANGES OF GEORGIA. Ga. Agr. Exp. Sta. Tech. Bull. N. S. 2, 38 pp.
In studies between 1950 and 1954, steers made best weight gains on lightly stocked range. An average of 14.2 acres of burned forest range (equal to 8.5 acres of open range) produced gains of 160 pounds per steer from March to October. At 7.2 acres per steer, gains were 114 pounds. Forage utilization was closely related to acreage of burned range per steer. Grasses furnished 85 percent of the cattle diet. Herbaceous and shrubby vegetation was stable under annual burning, but gallberry and most herbs decreased in ground cover under continued grazing. Grasses decreased most where grazing intensity was greatest.

Halls, L. K., Hughes, R. H., Rummell, R. S., and Southwell, B. L. 1964. FORAGE AND CATTLE MANAGEMENT IN LONGLEAF-SLASH PINE FORESTS. U. S. Dep. Agr. Farmers' Bull. 2199, 25 pp.
Recommendations for maintaining a balance between cattle, forage, and trees for the bluestem and pineland threeawn range types.

Halls, L. K., Knox, F. E., and Lazar, V. A. 1957. COMMON BROWSE PLANTS OF THE GEORGIA COASTAL PLAIN. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 75, 18 pp.
Descriptions and chemical and mineral composition of common browse plants in the longleaf-slash pine type.

Halls, L. K., Southwell, B. L., and Knox, F. E. 1952. BURNING AND GRAZING IN COASTAL PLAIN FORESTS, A STUDY OF VEGETATION AND CATTLE RESPONSES TO BURNING FREQUENCY IN LONGLEAF-SLASH PINE FORESTS OF GEORGIA. Ga. Coastal Plain Exp. Sta. Bull. 51, 33 pp.
Cattle showed a definite preference for burned areas and made better gains on burned than on unburned ranges. On moderately grazed areas fires kept gallberry in check. Effects on the various grass, herbaceous, and shrubby species varied with timing of the burns, grazing intensity, and other factors. Burning appears essential for maximum cattle production.

Halls, L. K., and Suman, R. F. 1954. IMPROVED FORAGE UNDER SOUTHERN PINES. J. Forest. 52: 848-851.
Improved forage species, Trifolium repens, Paspalum dilatum, *and* Axonopus affinis, *can be established under* Pinus palustris/P. elliottii *stands without tillage when litter is burned and fertilizer and lime applied. The relation between forage production and basal area per acre, the effect of needle cast, and the place that grazed sods can have in fire protection are discussed. FA*

Hopkins, W. 1952. GRAZING IN THE CUT-OVER LONGLEAF PINE REGION. J. Forest. 50: 384-386.
Cattle, unlike pigs, sheep, and goats, do comparatively little damage to pine regeneration, which they graze only in winter. Examination of grazed longleaf pine reproduction showed a reduction in growth but no increase in mortality. FA

Reid, V. H. 1954. MULTIPLE LAND USE: TIMBER, CATTLE, AND BOBWHITE QUAIL. J. Forest. 52: 575-578.
A detailed argument to show that with proper coordination timber and cattle can be grown together on longleaf pine land, of which there are ca. 15-20 million acres in the South. Fire is used both by foresters and graziers in this management and judiciously used fire can be beneficial in these woods for quail (Colinus virginianus) *also. FA*

Rummell, R. S. 1956. TREES AND CATTLE ON LONGLEAF-SLASH PINE LANDS. Consultant 1(4): 2-8.
Problems in using longleaf-slash pine lands for tree and cattle raising.

Shepherd, W. O. 1953. EFFECTS OF BURNING AND GRAZING FLATWOODS FOREST RANGES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 30, 2 pp. *Also as* EFFECTS OF BURNING AND GRAZING. Nav. Stores Rev. 63(12): 17, 20.
See entry under Halls, Southwell, and Knox, 1952.

Shepherd, W. O., Southwell, B. L., and Stevenson, J. W. 1953. GRAZING LONGLEAF-SLASH PINE FORESTS. U. S. Dep. Agr. Circ. 928, 31 pp.
Results of a 5-year study of breeding herds on wiregrass range in southern Georgia; range use as influenced by burning; also range plants and forage quality, number and size of calves, factors limiting herd productivity, influences of fall and winter herd management practices.

Smith, L. F. 1949. TIMBER DENSITY IMPORTANT FACTOR IN FOREST GRAZING. Miss. Farm Res. 12(12): 6, 8.
In a longleaf pine forest of south Mississippi, density of timber was the most important influence on grass production. In 1947 maximum air-dry weights of grass were 585, 309, and 214 pounds per acre in open, medium, and dense pine stands.

Smith, L. F., and Blount, C. L. 1952. EXPERIMENT STATION STUDY SHOWS VALUE OF WOODLAND GRASS IN SOUTH MISSISSIPPI. Miss. Farm Res. 15(11): 1, 6.
In a 2-year trial in southern Mississippi, a herd grazing longleaf pine forest pastures for a 4-month season gained more than a herd grazing 8 months.

Smith, L. F., Campbell, R. S., and Blount, C. L. 1955. FORAGE PRODUCTION AND UTILIZATION IN LONGLEAF PINE FORESTS OF SOUTH MISSISSIPPI. J. Range Manage. 8: 58-60.
Maximum yields per month over 3 years amounted to 850, 450, and 400 pounds air-dry grass per acre in open, moderate, and dense stands, respectively. The best quality of forage and the best cattle gains occurred in the early part of the growing season. A much higher utilization of grass occurred on fresh burns, owing to the removal of needle litter.

Smith, L. F., Campbell, R. S., and Blount, C. L. 1958. CATTLE GRAZING IN LONGLEAF PINE FORESTS OF SOUTH MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 162, 25 pp.
A study of amount and nutritive value of forage under second-growth stands of varying ages and densities. Under the moderate to light grazing of the study, damage to pine reproduction was light except on local areas of cattle concentration, but planted areas of Liriodendron tulipifera *needed fencing to prevent serious browsing. FA*

Southwell, B. L., and Halls, L. K. 1955. SUPPLEMENTAL FEEDING OF RANGE CATTLE IN LONGLEAF-SLASH PINE FORESTS OF GEORGIA. J. Range Manage. 8: 25-30.
Grade Hereford cows were grazed on native range except for a 6-weeks' period in February and early March. During the off-range period the cows were fed a maintenance ration. While on the range, some cows were given a supplement of cottonseed meal or furnished some improved pasture, and these measures increased the calf crop and calf size.

Williams, R. E. 1952. BETTER MANAGEMENT ON LONGLEAF FOREST RANGES. J. Range Manage. 5: 135-140.
Good range management practices implement woodland development and permit efficient use of improved pastures.

27 ARBORETA

Kraus, J. F. 1963. THE OLUSTEE ARBORETUM—PERFORMANCE OF 67 SPECIES OF FOREST TREES. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-4, 47 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
The Olustee Arboretum was started in north Florida in 1954 as an introduction and breeding garden of exotic pines used by the naval stores industry. Survival and growth are described. Hybrids of Pinus palustris *and* P. elliottii *var.* elliottii *are included.*

Schmitt, D., and Namkoong, G. 1965. PINE SPECIES IN THE HARRISON EXPERIMENTAL FOREST ARBORETUM. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-18, 18 pp. Southern Forest Exp. Sta., New Orleans, La.
Pines of 45 species, five native and 40 nonnative, were planted between 1955 and 1962. Of the nonnatives, 20 failed, and none have approached slash pine in growth, although some have become reproductively mature.

28 HUSBANDRY OF OTHER PRODUCTS: NAVAL STORES

Bengtson, G. W., Larson, P. R., Clements, R. W., and Schopmeyer, C. S. 1959. NEW SHORT-SEASON METHOD PRODUCES GOOD YIELDS FOR GUM FARMERS. Nav. Stores Rev. 68(11): 6-7.
Short-season chipping and acid treatment give good results. Chipping should begin in mid-April on longleaf but may be delayed until early May on slash pine. The final stock should be applied in September.

Clements, R. W. 1948. RESULTS OF 1947 PILOT PLANT TESTS OF CHEMICAL STIMULATION. Nav. Stores Rev. 58(31): 15-16.
On both longleaf and slash pines chemical stimulation saved labor, prolonged the life of the working faces, and reduced loss of wood in the butt log.

Clements, R. W. 1949. GOOD GUM GRADES OBTAINED WITH ACID TREATMENT. AT-FA J. 11(10): 9. *Also in* Nav. Stores Rev. 59(40): 17, 26-27.
In a 3-year test, grade yields from acid-treated longleaf and slash pines equalled those from the untreated trees.

Clements, R. W. 1950. RESULTS OF 1949 PILOT-PLANT TESTS OF CHEMICAL STIMULATION. Nav. Stores Rev. 60(27): 15, 26-27.
Methods tested in 1949 were: (1) freshening of the lower part of the stem ('bark chipping') with acid treatment on Pinus caribaea *and* P. palustris, *and (2) freshening of the upper part of the stem ('bark pulling') with acid treatment on* P. palustris, *both on a 2-weekly basis and with 50 percent* H_2SO_4. *These methods were compared with the regular weekly freshening without acid. On a basis of yield per freshening per 1,000 faces, treated* P. palustris *yielded 136 percent and 131 percent more resin under (1) and (2) respectively than untreated. Results with* P. caribaea *were variable but, on the same basis, treated freshenings averaged twice as much resin as the untreated. Cost's of equipment and labor at present rates are discussed with special reference to the saving effected by the 2-weekly acid treatment method. FA*

Clements, R. W. 1954. NAIL THAT EXTRA GUM PROFIT. Nav. Stores Rev. 64(5): 14. *Also in* AT-FA J. 16(11): 13.
In pilot plant tests, longleaf pines with tins nailed on produced 74.4 barrels more gum per crop over a 2-year period than did similar timber with tins inserted in broadaxe incisions.

Clements, R. W. 1959. POSSIBILITIES OF GUM PRODUCTION IN SOUTH FLORIDA. Nav. Stores Rev. 69(6): 8-9.
Results are presented of resin-yield studies made in stands of Pinus elliottii *var.* elliottii *and* P. palustris *in south Florida. Yields from a total of 17 streaks on trees of 10-12 inches d.b.h. in each of the three stand types, compared favorably with those recorded from comparable slash and longleaf pine in north Florida and south Georgia. The late-season yields were exceptionally good. Monthly yield data indicate that in pure stands of South Florida slash pine it*

is not profitable to apply streaks before mid-March. For mixed slash and longleaf the first streak may be applied some time after March 1. Transport and labor, however, both present some problems in this region. FA

Clements, R. W. 1961. AIR TEMPERATURE AND GUM YIELD. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 168, 2 pp.
In a study covering the tapping months April to November (in southern Mississippi), 1958 to 1960, resin yield of longleaf pine rose and fell with mean monthly temperatures. The first four months, contrary to accepted belief, yielded <50 percent of the total. July and August were the months of greatest flow. FA

Clements, R. W. 1961. PROFITABLE GUM PRODUCTION FROM LIMITED-FACE-HEIGHT LEASES. Nav. Stores Rev. 71(2): 6-7.
A study was made of modified extraction methods in a longleaf pine stand with the object of producing a satisfactory yield of resin from a 3-year lease with a face-height limitation of 54 inches. Fortnightly bark freshening with streaks 1 inch high treated with 60 percent H_2SO_4 produced 6 percent more resin over the 3-year period than weekly freshening with ½-inch streaks and 50 percent H_2SO_4. It was also easier for laborers to maintain the correct streak height. An efficient technique and good planning are essential in this type of short-term operation. FA

Clements, R. W. 1961. SCRAPE YIELD FROM LONGLEAF, SLASH GREATER THAN OTHERS. Nav. Stores Rev. 71(6): 4-5.
Pilot-plant tests at the Lake City Research Center indicate that 20-24 percent of the season's total yield from longleaf pine is in the form of scrape, vs. 1-8 percent from slash pine. The difference is due to the chemical composition of the resin. Recommendations are briefly given for the collection of scrape and for the elimination of clogging around the tins. FA

Clements, R. W. 1962. LOUISIANA PINE FORESTS PRODUCE LIQUID GOLD. Nav. Stores Rev. 72(6): 4-6, 18.
Commercial production of oleoresin is possible from second-growth longleaf and slash pine plantations in Louisiana.

Clements, R. W. 1963. FOUR YEARS OF GUM PRODUCTION ON POLE TIMBER. Southern Lumberman 207(2585): 131-133.
Intensive chipping—2 years on the front face and 2 years on the back face—is economically feasible and reduces face height on trees to be used for poles.

Clements, R. W. 1964. FOUR YEARS OF GUM PRODUCTION WITH A TOTAL FACE HEIGHT OF ONLY 45 INCHES. AT-FA J. 26(4): 5-8. *Also as* BACK CUPPING PRODUCES MORE GUM AND REDUCES TOTAL FACE HEIGHT. Nav. Stores Rev. 73(11): 8-9, 17.
See entry above.

Clements, R. W. 1965. SULFURIC ACID PASTE SHOWS PROMISE AS MEANS OF REDUCING PRODUCTION COSTS. Nav. Stores Rev. 75(3): 7, 11.
Presents the results of 2 years' tests in Florida in tapping slash and longleaf pine, using H_2SO_4 paste as a stimulant. Comparative yields are given from (1) standard fortnightly freshenings, (2) 3-weekly freshenings with paste, and (3) monthly freshenings with paste. Yields from (3) were 88 percent of those from (1) for both species, a slight reduction that would be offset by the large reduction in labor costs. FA

Clements, R. W. 1967. ACID PASTE METHOD HIGHLY SUCCESSFUL IN COMMERCIAL OPERATIONS. Nav. Stores Rev. 77(6): 4, 6, 9. *Also in* AT-FA J. 30(1): 4, 6-7.
In a 2-year evaluation on slash and longleaf pines, 22 paste streaks produced as much gum as 32 acid-spray streaks. By using paste at 21-day intervals, each chipping laborer increased his gum production per streak by 46 percent.

Clements, R. W., and Cross, J. K. 1964. BACK CUPPING PRODUCES MORE GUM THAN FRONT FACES IN MISSISSIPPI TEST. Nav. Stores Rev. 74(3): 4, 6.
Two methods were tested in a natural longleaf pine stand on all trees $\geq$ 10 inches d.b.h.: (1) freshening every 2 weeks, using 60 percent H_2SO_4 and a 1-inch streak height, and (2) weekly freshening, using 50 percent H_2SO_4 and a ½-inch streak height. All trees were worked for 3 years on the front, and 3 years on the back. Excellent yields were obtained but (2) gave no advantage over (1). No more than 17 freshenings should be made in a single year, and a 4-inch interspace must be maintained over the back-cupping period. FA

Clements, R. W., and Harrington, T. A. 1965. GUM NAVAL STORES FROM PLANTATION. *In* A Guide to Loblolly and Slash Pine Plantation Management in Southeastern USA, pp. 199-210. W. G. Wahlenberg (ed.). Ga. Forest Res. Counc. Rep. 14.
Pine gum and timber are compatible products from good management of forest plantations in the Southeast.

Croker, T. C., Jr. 1950. WIDE FACES BOOST GUM YIELD. Forest Farmer 9(11): 14. *Also in* Nav. Stores Rev. 60(31): 22-23.
Increasing width of naval stores faces from 9 to 14 inches increased gum production from 126 barrels per crop (10,000 faces) to 199 barrels. Results are from a 40-acre longleaf-slash pine tract in south Alabama.

Ferguson, J. H. A. 1948. RESIN AND TURPENTINE PRODUCTION IN THE U.S.A. Tectona 38(1): 3-11.
Chiefly a review of recent work by the Southeastern Forest Experiment Station on resin-tapping of longleaf and slash pines, with special reference to the use of chemical stimulants and work on selection and breeding. FA

Harrington, T. A. 1964. NEW RESEARCH IN GUM EXTRACTION METHODS AT NAVAL STORES AND TIMBER PRODUCTION LAB. Nav. Stores Rev. 74(2): 6-7, 16.
Outlines two studies in progress at the Southeastern Forest Experiment Station: (1) A 2 percent aqueous solution of 2,4-D has been successful on slash pine, but will kill longleaf. In comparative tests over 4 years, slash pine treated with 2,4-D produced 4 percent more resin than trees treated with H_2SO_4; this treatment did not corrode gutters and cups, and maintained a high-grade product over the second and third years, while H_2SO_4 treatments gave progressively lower grades. (2) H_2SO_4 applied as a paste, instead of a liquid, reduces corrosion of metal gutters and cups and, because of its direct and more lasting contact, is more effective, offering the possibility of lengthening the intervals between freshenings from 2 to 3, or even 4 weeks. FA

Harrington, T. A. 1965. PLANNING FOR THE FUTURE OF GUM NAVAL STORES. AT-FA J. 28(3): 9-12.
Prospects for improved efficiency through research-developed mechanization of chipping, and gum-collection methods.

Harrington, T. A. 1966. USING ACID PASTE—A NEW GUM PRODUCTION TECHNIQUE. AT-FA J. 28(8): 9-11.
A new stimulant for oleoresin production, sulfuric acid paste, works equally well on slash and longleaf pine. The paste remains potent for 4 weeks, thus reducing labor needs for chipping.

Hawley, N. R. 1959. ANOTHER LOOK AT THAT SMALL TREE. AT-FA J. 21(12): 11.
Discusses yields of oleoresin in relation to d.b.h. and crown-

length ratios for longleaf and slash pines. Impressive gains in yield are shown for larger trees with high crown-length ratios.

Hawley, N. R. 1966. GUM NAVAL STORES, AN ANCIENT FOREST INDUSTRY. AT-FA J. 28(4): 4, 6-7.
Brief history of the industry in the Southeastern U. S. Potential returns from gum farming are discussed.

Lane, J. M. 1967. 366 BARRELS OF GUM FROM 8 MONTHLY PASTE STREAKS. Nav. Stores Rev. 77(2): 4, 8.
In a 4-year study at Olustee, Florida, first-season resin yields obtained by applying (a) *60 percent* H_2SO_4 *paste to eight streaks at 28-day intervals and* (b) *50 percent aqueous solution of* H_2SO_4 *to 16 streaks every 2 weeks were, on* Pinus elliottii *and* P. palustris *respectively,* (a) *280, 366, and* (b) *315, 418 barrels. Details of the acid-paste treatment are described, and its merits (economy of labor, reduced iron contamination of resin) are discussed. FA*

Larson, P. R., and Clements, R. W. 1953. MORE GUM WITHOUT BROADAXE INCISIONS. Nav. Stores Rev. 63(20): 12, 13. *Also in* AT-FA J. 16(1): 8-9.
Gum yields of longleaf pine have been increased by as much as 60 barrels per crop merely by nailing on gutters and aprons instead of inserting tins in broadaxe incisions.

Liang, J.-H. 1965. [INVESTIGATION AND STUDY ON THE YIELD OF TURPENTINE AND OTHER SOME THINGS ABOUT PLANTATION OF EXOTIC PINES WHICH ARE PLANTED IN TAIWAN.] Taiwan Forest. Res. Inst. Bull. 107, 20 pp.
Lists exotic pines grown in Taiwan (with a key) and gives figures for diameter and height at different ages for Pinus palustris, P. rigida, P. radiata, P. insularis, P. densiflora, P. echinata *and, with additional figures for resin yields,* P. elliottii, P. luchuensis, P. thunbergii, *and* P. taeda. *FA*

Moore, W. H. 1949. RESULTS FROM USING SULPHURIC ACID TO PROLONG GUM FLOW. Nav. Stores Rev. 59(22): 12, 18-19.
Some practical conclusions reached by the Southern Resin and Chemical Co., Glen Saint Mary, Florida, on sulphuric-acid stimulation, after using the method on a commercial scale since 1945. Acid stimulation was found very adaptable to low-yielding longleaf pine (Pinus palustris), *20 acid streaks producing about the same total yields as 32 regular nonacid streaks. It is particularly useful in stands requiring thinning, where trees to be eliminated can be selected for tapping 3 or 4 years before they are felled, the larger trees remaining for future tapping. Freshening twice every 3 weeks was found preferable to once every 2 weeks, the face being extended by only ½ inch each time. FA*

Page, R. H. 1963. IMPACT OF NAVAL STORES ON UTILIZATION OF LONGLEAF AND SLASH PINE TIMBER. Forest Prod. J. 13: 361-364.
Briefly reviews the effect of resin tapping by modern methods of quality and uses, including preservative treatment, and reports on an inquiry among five southern pulp mills and seven sawmills. This indicates that prices paid for pulpwood from bark-hacked, acid-treated trees are no lower than for unworked trees, provided that they are free of metal (from lips) and excessive bark ingrowth, but that some sawmillers have trouble with embedded metal and complain that hard rosin dulls saws and knives. FA

Quinn, G. M., and Bengtson, G. W. 1957. GUM YIELD TABLES FOR INTENSIVELY WORKED SLASH AND LONGLEAF PINES. AT-FA J. 19(12): 4, 5. *Also in* Nav. Stores Rev. 67(5): 6-7.
In overstocked stands, trees 8 inches and smaller in diameter yielded less than 200 barrels of gum per crop. Presents gum-yield tables by diameter and by crown-length percentage.

Schopmeyer, C. S. 1948. EFFECT OF 2,4-D ON YIELDS OF OLEORESIN FROM SLASH AND LONGLEAF PINES. Sci. Mon. 67(6): 440-443.
Among chemicals tested in search of a noncorrosive harmless substance to replace H_2SO_4 *for treating faces on* Pinus palustris *and* P. caribaea, *2,4-dichlorophenoxyacetic acid is one of the most promising. Applications of the morpholine salt of 2,4-D gave yields equal to those usually obtained commercially with* H_2SO_4. *Results of these tests are tabulated. Research on the commercial value of 2,4-D treatment, and its effect on the tree, will be continued. FA*

Schopmeyer, C. S. 1954. ACID-TREATMENT—THE CHIPPER'S HELPER. AT-FA J. 16(8): 10.
A description of the resin ducts of slash and longleaf pine trees and how acid treatment prolongs gum flow from them.

Schopmeyer, C. S., and Larson, P. R. 1954. GUM-YIELD TABLES FOR SLASH AND LONGLEAF PINE ON POORER THAN AVERAGE SITES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 69, 2 pp. *Also in* Nav. Stores Rev. 65(1): 14-15. 1955.
Tabulates yields for slash pine (site index 70) and longleaf pine (site index 65) from (1) d.b.h. and crown-length ratio and (2) d.b.h. and number of rings in last inch of radial growth.

Schopmeyer, C. S., and Larson, P. R. 1954. PREDICTING GUM YIELDS FROM TREE MEASUREMENTS. AT-FA J. 17(1): 8-9. *Also in* Nav. Stores Rev. 64(7): 10-11, 17.
The relationships of gum yields to tree diameter, crown size, and growth rate are given for slash pine and longleaf pine worked with bark chipping and treated with sulfuric acid.

Schopmeyer, C. S., and Larson, P. R. 1955. EFFECTS OF DIAMETER, CROWN RATIO, AND GROWTH RATE ON GUM YIELDS OF SLASH AND LONGLEAF PINE. J. Forest. 53: 822-826.
In a local study, using bark-chipped, acid-treated streaks, the regression equations for yield were: Pinus elliottii, $Y = -242.7 + 28.49\ D + 390.6\ CR$ *and* $Y = -241.3 + 28.44\ D + 1094\ RW$; Pinus palustris, $Y = -223 + 25.13\ D + 366.7\ CR$ *and* $Y = 190.1 + 26.66\ D + 1163\ RW$, *where* Y = *mean annual yield in barrels of 435 pounds per 10,000 faces;* D = *d.b.h. (ins.);* CR = *crown length per total height of tree; and* RW = *mean ring width (in.) of the outermost inch. Using D alone gave higher significant correlations but, owing to the wide range with* D *of* CR, *which is strongly affected by stand density, such equations are unlikely to be of wide application. The introduction of* RW *did not increase precision, but may be useful in examining the effect of site. The silvicultural and economic implications of these facts are discussed. On sites poorer than average the present minimum diameter of 9 inches should be raised to at least 10 for a profitable tapping operation. FA*

Schopmeyer, C. S., and Maloy, O. C. 1960. DRY FACE OF NAVAL STORES PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 51, 7 pp.
Describes the condition and its more serious form, pitch-streak, on Pinus elliottii *and, less frequently,* P. palustris, *and discusses causes (chiefly moisture stress through drought, an inadequate crown, or poor techniques impairing water conduction), prevention and control. Though no fungus has been proved a primary cause, certain species are thought to accelerate extension and aggravate the condition. FA*

Snow, A. G., Jr. 1948. EFFECT OF SULFURIC ACID ON GUM YIELDS FROM SLASH AND LONGLEAF PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Tech. Note 68, 35 pp.
Summarizes, through 1946, intensive experiments begun in 1944.

Snow, A. G., Jr. 1948. TURPENTINING AND POLES. Southern Lumberman 177(2225): 276, 278-279.
Pines tapped on two faces by the modern method of bark-depth freshenings plus acid treatment, yield in 3 years the equivalent of 5 years by the old method. The reduced tapping period produces poles of greater diameter and, since the faces are considerably shorter, less of the butt has to be cut off, so that the poles are also longer. Preservative penetration tests showed that in slash pine, penetration behind the modern face was satisfactory; but faces of longleaf pine required to be incised. The reason for this specific difference is not yet known. FA

True, R. P., and McCulley, R. D. 1945. DEFECTS ABOVE NAVAL STORES FACES ARE ASSOCIATED WITH DRY FACE. Southern Lumberman 171(2153): 200-202, 204.
Pitch-soak, stain, dry wood, and rot are frequently found in pine in the log cut from just above faces worked out for turpentine and resin. These defects are most pronounced above faces that have been burned, but are also found above unburned faces. It was found that most of the defects occurred above those faces or parts of faces that had been affected by dry face at the time chipping stopped. The prompt felling of worked out timber would limit the spread of pitch-soak and prevent the development of extensive rot; it would not reduce the stain.

True, R. P., and Snow, A. G., Jr. 1949. GUM FLOW FROM TURPENTINE PINES INOCULATED WITH THE PITCH-CANKER FUSARIUM. J. Forest. 47: 894-899. (Abstr.) Phytopathology 38: 572-573.
Treating freshly cut virgin faces with the pitch-canker fungus, Fusarium lateritium f. pini, *prolonged the period of commercially adequate resin flow (normally 1 week) to an average of 5 weeks for slash pine* (P. caribaea) *and 3 weeks for longleaf pine* (P. palustris). *Later freshening and retreatment of the same faces prolonged adequate flow for an average of 3 weeks with* P. caribaea *and for usually not more than 2 weeks with* P. palustris. *No reason is known to account for the difference between the prolongation induced by the initial and by later treatments. FA*

USDA Forest Service, Southeastern Forest Experiment Station. 1964. EFFECT OF 2,4-D ON GUM YIELDS FROM SLASH PINE. *In* 1963 research at the Southeastern Forest Experiment Station, p. 34.
In a 3-year trial, 2 percent 2,4-D in water has produced as much slash pine resin as 50 percent H_2SO_4. *The 2,4-D did not corrode lips and cups, so that resin quality was better. All 2,4-D treatments killed longleaf pine. FA*

USDA Forest Service, Southern Forest Experiment Station. 1946. AVERAGE GUM YIELD FROM LONGLEAF PINE AND SLASH PINE OF DIFFERENT DIAMETERS FOR GOOD AND POOR SITES. AT-FA J. 8(4): 10.
Gum yields in units per crop per season.

Wahlenberg, W. G. 1946. LONGLEAF PINE. V—NAVAL STORES OPERATIONS. Southern Lumberman 172(2158): 36-38.
Various aspects of naval stores operations. Growth and yield are discussed under three headings: growth after partial cutting, natural limits, and determination of volume and growth.

4. FOREST INJURIES AND PROTECTION

42 INORGANIC INJURIES

Jones, W. N. 1952. FUSED NEEDLE DISEASE IN PINUS PALUSTRIS. Empire Forest. Rev. 31: 325-326.
In spring 1950, 65 plants of P. palustris *sown in 1948 were transplanted from the nursery to the forest (Wareham, England). There was no trace of fused-needle disease during the period in the nursery, but several instances were noted during 1951 and, by May 1952, 41 of the 62 surviving plants were showing clear symptoms of the disease. Affected needles were restricted to those produced towards the end of the 1950 growing season and still unshed in 1952. It is suggested that the sudden and transitory development of the symptoms is related to reduction in the root's normal capacity for water absorption, caused by the removal of the plants to a new site. FA*

Muntz, H. H. 1947. ICE DAMAGE TO PINE PLANTATIONS. Southern Lumberman 175(2201): 142-145.
The upper half of Louisiana is an area of high risk for ice storms. As storms in 1944 and 1947 demonstrated, slash pine is more seriously damaged than the native loblolly and longleaf. For short rotations, slash may still be a good choice for planting in this area, but loblolly or longleaf should be planted if poles and saw logs are to be grown.

Poynton, R. J. 1966. THE DROUGHT RESISTANCE OF COMMERCIAL TIMBER SPECIES IN THE TRANSVAAL. *Bosb. Suid-Afr.* 6: 87-106.
Data are presented to illustrate the severity of the 1964 drought in the E. and N. Transvaal. Important commercial species in the area may be grouped into the broad classes: (1) resistant—Eucalyptus maculata, E. paniculata, *and* Pinus roxburghii; *(2) moderately resistant*—E. cloeziana, E. grandis, P. montezumae, P. elliottii, P. patula, P. pseudostrobus, *and* P. radiata; *and (3) somewhat susceptible*—E. fastigata, E.microcorys, P. palustris, *and* P. taeda. *FA*

43 FOREST FIRES: DAMAGES, PRESCRIBED BURNING

Bickford, C. A., and Newcomb, L. S. 1947. PRESCRIBED BURNING IN THE FLORIDA FLATWOODS. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 8(1): 17-23.
This paper describes methods of prescribed burning developed and used on the Osceola National Forest in northeast Florida in the longleaf-slash pine type. Fire protection in this type results in the extension of the more valuable slash pine, but it also leads to the accumulation of inflammable material and increased fire hazard. Slash pine about 6 feet in height and longleaf pine over 1 year old can stand slow-burning prescribed fire in the dormant season. The necessary measures of analysis, planning, preparation, and burning are described. The importance of thorough planning and preparation, training of crews, and obtaining reliable weather forecasts is stressed. FA

Bruce, D. 1947. THIRTY-TWO YEARS OF ANNUAL BURNING IN LONGLEAF PINE. J. Forest. 45: 809-814.
In 1915 the Roberts Plots were established near Urania, Louisiana, to test the effect of annual burning and grazing on longleaf pine seedlings. The following facts are presented: (1) Hogs destroy longleaf seedlings and can prevent

regeneration. (2) After the age of one year, longleaf seedlings (at least those on the better sites) can survive annual winter fires, and grow past the size at which they are retarded by these fires. (3) Exclusion of fire from longleaf land within the range of loblolly and shortleaf pines allows these species to encroach, even with heavy longleaf seedling stands. Annual fires killed all loblolly and shortleaf seedlings and permitted the development of a fully stocked longleaf stand.

Bruce, D. 1951. FIRE RESISTANCE OF LONGLEAF PINE SEEDLINGS. J. Forest. 49: 739-740.
Fire resistance of 1-year longleaf pine seedlings was found to be closely related to vigor classes (all vigorous seedlings and 75 percent of those in fair vigor, but none of the weak seedlings, survived). Vigor classes in turn were fairly closely related to groundline diameter. The older the seedlings were at the time of the fire, the better they survived: survival at 9 months was less than 10 percent, at 16 months 30 percent, and at 26 months 40 percent. The better survival of seedlings first burned at 2 years of age is probably due to their greater thickness (0.2-0.4 inch diameter compared with 0.1-0.2 inch for yearlings). FA

Bruce, D. 1951. FIRE, SITE, AND LONGLEAF HEIGHT GROWTH. J. Forest. 49: 25-28.
In a test started in south Mississippi in 1935, light and severe fires in 4-year-old longleaf pine regeneration caused no more mortality in the following 4 years than occurred on unburned plots. Both summer and winter fires, however, killed 46 percent and 26 percent respectively of trees in 9-year-old plots. Light fire when the seedlings were 4 years old stimulated height growth, probably by controlling brown-spot disease. Summer fires were more beneficial than winter ones. In another study on poorer soils in north Florida, it was found that the more frequent and more severe the fires, the lower the survival and the poorer the height growth. The best growth there was on unburned plots. Local differences in soil conditions had more influence on height growth than the fire treatments. No evidence was found that fire in open grassy areas altered the soil in any way. FA

Bruce, D. 1954. MORTALITY OF LONGLEAF PINE SEEDLINGS AFTER A WINTER FIRE. J. Forest. 52: 442-443.
After a moderately intense grass fire in 3-year-old Pinus palustris, *the percent mortality was graphed against seedling height for 4 degrees of defoliation by* Scirrhia acicola. *Controlled burning before many seedlings are 1/3 defoliated is recommended. The 0-6 inch class survives best even when 2/3 defoliated. FA*

Bruce, D. 1955. LONGLEAF LED THE WAY. La. State Univ Fourth Annu. Forest. Symp. Proc. 1955: 79-83.
Longleaf pine was the first U. S. forest type in which fire was used silviculturally. The species' natural fire resistance, and the fuels and soils characteristic of longleaf sites, make successful prescribed burning easier than in the loblolly-shortleaf type.

Bruce, D. 1956. EFFECT OF DEFOLIATION ON GROWTH OF LONGLEAF PINE SEEDLINGS. Forest Sci. 2: 31-35.
Natural seedlings of P. palustris *are subject to defoliation by fire and fungus during the grass stage (2-30 years). The effect on the height and diameter growth of 18-month nursery seedlings of clipping off 30, 60, and 90 percent of the foliage was investigated. Clipping was done once in July, November, or the following February, or twice in various combinations. All defoliation caused loss of growth in rough proportion to severity; degree of clipping was more significant than the date, and two-stage clipping was generally worse than one 90 percent clipping. November was significantly worse than July clipping, and February clipping caused least damage, an endorsement of the practice of deferring controlled burning to January or February. FA*

Byram, G. M. 1948. VEGETATION TEMPERATURE AND FIRE DAMAGE IN THE SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 9(4): 34-36.
Damage is related to initial temperature of vegetation; size of needles, buds, and branch ending; and wind.

Byram, G. M., and Nelson, R. M. 1952. LETHAL TEMPERATURES AND FIRE INJURY. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 1, 2 pp. *Also in* Nav. Stores Rev. 62(20): 18.
The relation of time and temperature to killing of loblolly, longleaf, slash, and pitch pine needles immersed in a water bath varied little among species.

Chapman, H. H. 1947. PRESCRIBED BURNING VERSUS PUBLIC FOREST FIRE SERVICES. J. Forest. 45: 804-808.
The author recounts the steps which have led to the conversion of most, though not all, American foresters to the belief that controlled burning is an essential part of the management of longleaf pine and attacks the arguments of those still unconverted. He is now in favor of careful, prescribed burning at intervals of about 3 years both in order to obtain establishment of regeneration and in order to reduce fire hazard.

Chapman, H. H. 1947. RESULTS OF A PRESCRIBED FIRE AT URANIA, LA., ON LONGLEAF PINE LAND. J. Forest. 45: 121-123.
Report on experiments on cutover lands. Mortality of seedlings still in the grass from a hot winter headfire is negligible, especially when there is a dense stocking of seedlings. At the most vulnerable height, 6 inches to 3 feet, nearly half the seedlings were killed. Mortality of the 6- to 12-foot class was 20 percent. Hardwoods too large to be killed (above 2-inches diameter) by fire should be cut down in August, and on bare areas burned the following August. Blackjack oak 30 feet high and up to 5 inches in diameter have been successfully controlled.

Chapman, H. H. 1957. FORTY-YEAR EFFECT OF A SUMMER FIRE ON 4-YEAR-OLD LONGLEAF PINE AT URANIA, LOUISIANA. J. Forest. 55: 301-302.
A large number of 4-year pine seedlings were destroyed by a bad fire in summer 1917, and a second summer fire in 1924 killed many of the survivors. Measurements made at intervals on two permanent 1-acre plots showed that basal area (pines and hardwoods) increased from (a) 35.84 square feet and (b) 9.16 square feet in 1932 to (a) 146.42 square feet (ca. full stocking) and (b) 105.70 square feet in 1955. Controlled burns were done at 3-year intervals to prevent accidental fires. The plots now need thinning. FA

Dyer, C. D., and Brightwell, C. N. 1955. PRESCRIBED BURNING IN SLASH AND LONGLEAF PINE FORESTS OF GEORGIA. Univ. Ga. Coll. Agr. Ext. Serv. Bull. 594, 13 pp. *Also in* AT-FA J. 24(3): 6-8. 1961.
Instructions for prescribed burning.

Fahnestock, G. R., and Hare, R. C. 1964. HEATING OF TREE TRUNKS IN SURFACE FIRES. J. Forest. 62: 799-805.
Compares the effects of fires advancing with the wind (1) and against it (2), in a pole-size Pinus palustris *stand, unburned for 8 years and carrying 14 tons litter per acre, in south Mississippi. In (1), 60 percent of the litter was burned, vs. 49 percent in (2). Temperatures decreased generally with height above ground and reached 1600° F. briefly on the bark, where they were lower in fissures than on plates and higher on lee than on windward sides of stems, the difference increasing with height. With increasing*

height, temperatures were slightly greater on lee sides, but much greater on windward sides, in (1) than in (2). Crown scorching was also more severe in (1). Cambial injury occurred extensively only on lee sides of some trees in (1). FA

Hare, R. C. 1965. CONTRIBUTION OF BARK TO FIRE RESISTANCE OF SOUTHERN TREES. J. Forest. 63: 248-251.
Time required to kill cambium in situ *with a propane flame was a function of both thickness and thermal properties of the overlying bark; resistance was directly correlated with tree diameter. Of 14 pine and hardwood species longleaf and slash pine were most resistant, and sweetgum, cherry, and holly least resistant.*

Hare, R. C. 1965. SIMPLE HOT STAGE FOR STUDYING CRITICAL CELL TEMPERATURES. Can. J. Bot. 43: 777-778.
Trials with an easily constructed stage indicate that cells of longleaf pine stem tissue may be more heat-tolerant than cells of white pine.

Hills, J. T. 1957. PRESCRIBED BURNING TECHNIQUES IN LOBLOLLY AND LONGLEAF PINE ON THE FRANCIS MARION NATIONAL FOREST. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 18: 112-113.
Instructions for making checkerboard or spot fires, burning in strips, and using flanking fires.

Jorgensen, J., and Derr, H. J. 1958. YEARLING LONGLEAF SURVIVES A WILDFIRE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 114.
If weather is favorable during the first year, longleaf seedlings may reach a size that enables them to survive some accidental fires.

McCulley, R. D. 1948. EFFECT OF UNCONTROLLED FIRES ON LONGLEAF PINE SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 3.
In a study in northern Florida repeated severe fires killed many seedlings and reduced the growth of those that survived.

Miller, S. R., Malac, B. F., and Johnson, J. W. 1961. A CASE HISTORY OF SLASH AND LONGLEAF PINE SURVIVAL FOLLOWING A WINTER WILDFIRE. Union Bag-Camp Corp. Woodland Res. Note 11, 3 pp.
On sample plots established after a severe fire in Georgia, 72 percent of trees showing healthy cambium near the base survived after 3 years as against 43 percent showing injured cambium. Of dominants and codominants, 75 percent survived; of inferior classes, 35 percent. Of trees more than 6 inches d.b.h. 75 percent survived against 25 percent of those less than 6 inches. Mortality of both species was equal, but slash pine succumbed faster. FA

Muntz, H. H. 1947. PRESCRIBED BURNING OF LONGLEAF PLANTATIONS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 49.
See Wakeley and Muntz, 1947.

Reifsnyder, W. E., Herrington, L. P., and Spalt, K. W. 1967. THERMOPHYSICAL PROPERTIES OF BARK OF SHORTLEAF, LONGLEAF, AND RED PINE. Yale Forest. Bull. 70, 41 pp.
Barks of these three pines have no peculiarities in their thermal properties that would make them unusually effective in protecting the cambium from the heat of a fire. Bark thickness appears to be the primary factor in determining a tree's fire resistance.

Storey, T. G., and Merkel, E. P. 1960. MORTALITY IN A LONGLEAF-SLASH PINE STAND FOLLOWING A WINTER WILDFIRE. J. Forest. 58: 206-210.
Describes a study of 475 dominant and codominant Pinus palustris *and* P. elliottii *trees in largely even-aged 60-year mixed stands after the Buckland wildfire in Florida, March 1956. It was found that mortality could be estimated by the amount of crown consumed. About the same number of large and small trees of both species died from equal percents of crown consumption; 87 percent of trees died when* $> \frac{1}{2}$ *their needles were consumed by flame, and 42 percent when* $< \frac{1}{2}$ *were consumed. Even 100 percent needle-browning caused no tree death. Presumably this was because initial temperatures of the buds and cambium were low (air temperature was ca. 45° F. at the time of the fire) and were not raised to fatal level by the fire. Height of bark charring on the stem also was related to deaths: 88 percent died when* $\geq$ *80 percent of the stem length was charred, and 39 percent when 60-80 percent was charred. There were very few deaths when* $<$ *60 percent was charred. Beetle attack was light. FA*

USDA Forest Service. 1950. EFFECT OF BACKFIRES AND HEADFIRES ON LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 12.
In a test of the relative effects of backfires and headfires on longleaf pine seedlings, five pairs of plots were selected and one of each pair was burned with a headfire and the other with a backfire. The seedlings were about 3 years old with rootcollars from 0.2 to 0.3 inch in diameter. In plots burned by backfires 57 percent of seedlings died. In those burned by headfires 35 percent died.

USDA Forest Service. 1950. LONGLEAF SEEDLINGS WITHSTAND FIRE MUCH BETTER ON A COLD DAY. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 8.
With air temperature at 92° F. a longleaf pine seedling can tolerate a rise in temperature (as during a prescribed burn) of only 30° F. With air temperatures at 40° F. it can tolerate a rise of 100° F.

Wahlenberg, W. G. 1946. LONGLEAF PINE. IV—PROTECTION FROM FIRE. Southern Lumberman 172(2156): 33-34.
Discusses effects of fire, forest fuels, protective burning, and costs of protection. Also protection from insects, brown-spot needle disease, and other diseases. Climatic injuries are mentioned briefly.

Wakeley, P. C., and Muntz, H. H. 1947. EFFECT OF PRESCRIBED BURNING ON HEIGHT GROWTH OF LONGLEAF PINE. J. Forest. 45: 503-508.
Longleaf pines planted on a 40-acre tract in central Louisiana during 1935 were control-burned in January 1938 and again in February 1941, the purpose being to control brown-spot needle disease. A similar 60-acre stand was left unburned. By 1946, survival in the two plantations was the same but height growth was much better in the burned plantation.

44 DAMAGE BY PLANTS: DISEASES

Berry, C. R., and Hepting, G. H. 1959. PITCH CANKER OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 35, 3 pp.
Symptoms, a description of the pathogen, its importance, and control measures.

Boyce, J. S., Jr. 1951. LOPHODERMIUM PINASTRI AND NEEDLE BROWNING OF SOUTHERN PINES. J. Forest. 49: 20-24.
The fungus is probably not pathogenic to pines in the southeastern U. S., but readily invades needles attacked or weakened by other agencies.

Boyce, J. S., Jr. 1958. NEEDLE CAST OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 28, 4 pp.
Symptoms, causes, and control for pine needle blights, espe-

cially those caused by Scirrhia acicola *and* Hypoderma lethale.

Boyce, J. S., Jr. 1962. GREENHOUSE INOCULATIONS OF CONIFEROUS SEEDLINGS WITH FOMES ANNOSUS. (Abstr.) Phytopathology 52: 4.
When seed of Pinus taeda, P. palustris, P. echinata, P. elliottii, *and* P. strobus *was sown over infected pine roots buried 2-3 inches in the soil, infection was confirmed within a year only on the roots of two dying* P. echinata *seedlings and one apparently healthy* P. palustris. *When 1- or 2-year-old seedlings of* P. taeda, P. strobus, *and* Juniperus virginiana *were planted in pots containing infected root pieces, infection occurred in all species within a year—mostly in roots 1-2 mm. thick. In some inoculum pieces,* F. annosus *was still alive after 1 year in the soil. FA*

Bryan, W. C., and Zak, B. 1961. SYNTHETIC CULTURE OF MYCORRHIZAE OF SOUTHERN PINES. Forest Sci. 7: 123-129.
A pure-culture technique for mycorrhizal synthesis demonstrated mycorrhizal formation by eight fungi in association with roots of southern pines.

Campbell, W. A. 1949. NEEDLE CAST OF SOUTHERN PINES. Forest Farmer 9(1): 4, 10.
Needle cast can be caused by any of several fungi, the most common of which is Scirrhia acicola *(Dearn.) Siggers. Outbreaks occur at irregular intervals, but there is no evidence that the disease causes appreciable damage.*

Campbell, W. A. 1951. THE OCCURRENCE OF PHYTOPHTHORA CINNAMOMI IN THE SOIL UNDER PINE STANDS IN THE SOUTHEAST. Phytopathology 41: 742-746. *Also in* Rev. Appl. Mycol. 31: 41.
The abundance of the fungus was determined in 61 plots outside the littleleaf area. Isolations were obtained from soil of 48 percent of the 61 plots, regardless of the type of stand, and from 52 percent of 50 plots in stands containing shortleaf or loblolly pine, either pure or in mixtures. P. cinnamomi *was present in the soil in only 14 percent of seven plots in stands containing slash and longleaf pine.*

Cole, D. E. 1963. MANAGEMENT OF PINE SEED PRODUCTION AREAS. Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 44-49.
Cone rust may cause heavy losses of slash and longleaf conelets on the Gulf Coast and in north Florida. Methods for controlling it in seed-production areas are given.

Croker, T. C., Jr. 1967. CROP-SEEDLING METHOD FOR PLANNING BROWN-SPOT BURNS IN LONGLEAF PINE. J. Forest. 65: 488.
Brown-spot infection and expected fire damage on crop seedlings are better indicators of the need for prescribed burning than are such data taken on average seedlings.

Crosby, E. S., Jr. 1966. STUDIES IN THE MORPHOLOGY, LIFE HISTORY, AND PATHOGENICITY OF SCIRRHIA ACICOLA (DEARN.) SIGGERS. Diss. Abstr. 27B: 1352.
Describes the endospores and discusses factors affecting the germination of conidia. The ascospore stage was found on dead needles at Aiken, South Carolina, each month from February 1964 to April 1965, most abundantly in late spring and early summer; laboratory studies of ascospore ejection are described. Most attempts to produce infection of seedlings of longleaf pine failed, but inoculations with conidial suspensions on seedlings in outdoor beds were successful. FA

Foster, A. A. 1959. NURSERY DISEASES OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 32, 7 pp.
Causes, symptoms, and control of brown spot, black root rot, nematode injury, fusiform rust, and chlorosis in forest tree nurseries.

Hendrix, F. F., Jr., Kuhlman, E. G., Hodges, C. S., Jr., and Ross, E. W. 1964. FOMES ANNOSUS—A SERIOUS THREAT TO REGENERATION OF PINE. U. S. Dep. Agr. Forest Serv. Res. Note SE-24, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Studies were made in plantations in North and South Carolina: (a) *mixed pines on the site of a white pine plantation clear-felled because of severe* F. annosus *root rot;* (b) *loblolly pine on the site of a slash pine plantation clear-felled because of fusiform rust, but not known to be infected with* F. annosus; (c) *slash pine on the site of a clear-felled longleaf pine/scrub oak stand. Results indicate that the fungus must be considered a serious problem on former forest lands. In* (a) *2 years after planting, mortality attributable to* F. annosus *was 2 percent for shortleaf, 1.5 for Virginia, 0.7 for Scots and 0.6 for white pine, but only 0.4 for natural white pine regeneration. In* (b) *mortality of loblolly pine from this cause averaged 2.68 percent per annum 4 years after planting, and in* (c) $>$ *5 percent killed slash pine were counted 2 years after planting on the most seriously infected plots, plus 11-17 percent infected living trees. Spread was from infected stumps, and from seedling to seedling. FA*

Henry, B. W. 1953. A ROOT ROT OF SOUTHERN PINE NURSERY SEEDLINGS AND ITS CONTROL BY SOIL FUMIGATION. Phytopathology 43: 81-88.
A root rot occurring at a U. S. Forest Service nursery near Brooklyn, Miss., killed large numbers of Pinus taeda *and damaged* P. echinata *and* P. palustris. P. caribaea *was less susceptible. The cause of the rot was not discovered, but applications of 24 gallons per acre of a 20 percent-by-volume solution of ethylene dibromide, 2-3 weeks before spring sowing, gave excellent control, and two to three successive annual treatments eliminated all damage to following pine crops. FA*

Henry, B. W. 1953. EFFECTS OF ETHYLENE DIBROMIDE ON NEMATODES ASSOCIATED WITH A ROOT ROT OF SOUTHERN PINE SEEDLINGS. (Abstr.) Phytopathology 43: 474-475.
See entry above.

Henry, B. W. 1954. NEW LIGHT ON SPREAD OF BROWN SPOT. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 90.
Ascospores, one of the two kinds of spores that transmit the brown-spot needle blight of longleaf pine seedlings, have recently been found to occur at all seasons of the year.

Henry, B. W. 1954. SPORULATION BY THE BROWN SPOT FUNGUS ON LONGLEAF PINE NEEDLES. Phytopathology 44: 385-386.
In an attempt to determine the role of ascospores of Scirrhia acicola *in the epidemiology of brown-spot disease, the frequency was investigated of ascospore occurrence on longleaf pine needles in nature. Ascospores were found every month from February 1952 to January 1953 on dead needles and necrotic distal portions of needles. FA*

Henry, B. W. 1959. DISEASES AND INSECTS IN THE SOUTHWIDE PINE SEED SOURCE STUDY PLANTATIONS DURING THE FIRST FIVE YEARS. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 12-17.
Two pests have been of major importance. Tip-moth injury is severe in most shortleaf and loblolly plantations, irrespective of seed source, and is impeding height growth. Intensity of fusiform rust is variable among the slash and loblolly plantations. Its incidence consistently differs between seed sources in loblolly plantings, but in only one case with slash pine.

Henry, B. W., and Hepting, G. H. 1957. PEST OCCURRENCES IN 35 OF THE SOUTHWIDE PINE SEED SOURCE STUDY PLANTATIONS DURING THE FIRST THREE YEARS. U. S. Dep. Agr. Forest

Serv. Southern Forest Exp. Sta., 7 pp.
Drought has caused most of the mortality so far. Fusiform rust is building up rapidly. The Nantucket tip moth is widespread in loblolly and shortleaf plantings, and may be retarding height growth appreciably. Brown-spot needle disease is being controlled in longleaf plantations with fungicides, but it and Hypoderma needle blight may be causing growth loss on loblolly. No other pests yet appear serious.

Henry, B. W., and Wells, O. O. 1967. VARIATION IN BROWN-SPOT INFECTION OF LONGLEAF PINE FROM SEVERAL GEOGRAPHIC SOURCES. U. S. Dep. Agr. Forest Serv. Res. Note SO-52, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
In plantings in southern Mississippi, seedlings from seed sources near the western extremity of the range were generally more heavily infected than seedlings from the central part.

Hepting, G. H. 1959. DISEASE LOSSES IN SOUTHERN PINE SEED DURING CONE PRODUCTION. *In* Direct Seeding in the South, 1959, a Symposium, pp. 36-39. Duke Univ.
The most important cone disease is a rust caused by Cronartium strobilinum. *It afflicts slash and longleaf pines; oaks are alternate hosts. Some control measures are mentioned.*

Hepting, G. H. 1962. THE TOP FIVE AMONG FOREST DISEASES OF THE SOUTH. Forest World 1(3): 35-38.
The five most serious forest tree diseases in the South are hardwood decays, fusiform rust, littleleaf disease, brown-spot needle blight, and annosus root rot.

Hepting, G. H., and Fowler, M. E. 1962. TREE DISEASES OF EASTERN FORESTS AND FARM WOODLANDS. U. S. Dep. Agr. Forest Serv. Agr. Inform. Bull. 254, 48 pp.
Comprehensive review.

Hepting, G. H., and Lindgren, R. M. 1950. COMMON SOUTHERN FOREST TREE DISEASES. Forest Farmer 9(5): 31-33.
Brief descriptions and control measures.

Hodges, C. S., Jr. 1962. DISEASES IN SOUTHEASTERN FOREST NURSERIES AND THEIR CONTROL. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 142, 16 pp.
Describes the more common diseases, including those caused by nematodes and by Cylindrocladium scoparium, Cronartium fusiforme, Scirrhia acicola, Rhizoctonia, Phomopsis juniperovora, *and* Cercospora sequoia, *and their control, covering general methods of application and including lists of formulations and application rates, and of suppliers. FA*

Jewell, F. F. 1963. HOW CAN GENETIC CONTROL OF DISEASES AID THE FOREST MANAGER? Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 25-26.
Disease-resistant trees may be among the earliest practical results of forest genetics research.

Kais, A. G. 1964. GERMINATION AND GROWTH OF SCIRRHIA ACICOLA IN LIQUID CULTURE INHIBITED BY CYCLOHEXIMIDE SEMICARBAZONE. U. S. Dep. Agr. Plant Dis. Reporter 48: 553-556.
Dry weights of mycelium indicated no significant differences among concentrations of the antibiotic (0.1, 1.0, 10.0, or 100.0 p.p.m.), but differences were significant between the antibiotic treatments and a water control, between the antibiotics and an alcohol control, and between the water and alcohol controls. Spore germination and subsequent growth decreased as the concentration of the antibiotic was increased. Germination and growth of the antibiotic-treated spores resumed when the spores were transferred to potato-dextrose agar.

Lightle, P. C. 1960. BROWN-SPOT NEEDLE BLIGHT OF LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 44, 7 pp.
Hosts, distribution, symptoms, life history, pathogenicity, and control.

Lindgren, R. M. 1948. THINNING PINES CANKERED BY FUSIFORM RUST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 55. *Also in* Nav. Stores Rev. 58(9): 6.
Rules for thinning trees cankered by fusiform rust. Longleaf is generally much more resistant than slash or loblolly pines but 20 to 30 percent infection may occur in areas of high rust hazard.

Lindgren, R. M. 1951. THE DISEASE PROBLEM IN RELATION TO TREE IMPROVEMENT. First Southern Conf. on Forest Tree Impr. 5 pp.
Discusses the possibilities of alleviating disease problems through tree improvement, with special emphasis on the dangers involved. There is strong evidence that strains of longleaf pine resistant to brown spot could be selected.

Lindgren, R. M., and Henry, B. W. 1949. PROMISING TREATMENTS FOR CONTROLLING ROOT DISEASE AND WEEDS IN A SOUTHERN PINE NURSERY. U. S. Dep. Agr. Plant Dis. Reporter 33: 228-231.
At the W. W. Ashe Nursery near Brooklyn, Miss., two fumigants, chloropicrin and ethylene dibromide, were outstandingly successful in controlling root disease.

Maloy, O. C., and Matthews, F. R. 1960. SOUTHERN CONE RUST: DISTRIBUTION AND CONTROL. U. S. Dep. Agr. Plant Dis. Reporter 44: 36-39.
See abstract under Matthews and Maloy, 1960.

Mann, W. F., Jr., and Scarbrough, N. M. 1948. CLOSE SPACING REDUCES FUSIFORM RUST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 53. *Also in* Forest Farmer 7(5): 12. *Also in* Nav. Stores Rev. 58(34): 6.
Longleaf and slash pines were planted in alternate rows in southern Mississippi. After 11 years, 1.5 percent of the longleaf were infected with rust, as contrasted with 22 to 43 percent of the slash pines.

Matthews, F. R. 1967. SOUTHERN CONE RUST, CRONARTIUM STROBILINUM (ARTH.) HEDGC. AND HAHN. *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico. Can. Dep. Forest. and Rural Develop. Pub. 1180, pp. 225-227.
Longleaf pine is listed as a host.

Matthews, F. R., and McLintock, T. F. 1958. EFFECTS OF FUNGICIDES ON POLLEN GERMINATION OF SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 122, 2 pp.
Of four fungicides tested at 2 or 0.2 pounds (or pints) per 100 gallons of water in connection with Cronartium strobilinum *control, Puratized Agricultural Spray (an organic mercurial) was 100 percent lethal. Captan and Basi-cop (tribasic Cu sulphate) markedly inhibited germination, but ferbam actually stimulated it, the higher concentration being better on longleaf, the lower on slash. Whether ferbam is effective against the fungus is still under investigation. FA*

Matthews, F. R., and Maloy, O. C. 1960. WHAT TO DO ABOUT CONE RUST. Forest Farmer 19(4): 8, 14-15.
Cone rust destroys first-year cones of slash and longleaf pine. The main area of infection extends from central Florida to the southernmost counties of Georgia, and westward along the Gulf Coast through southern Mississippi. Since evergreen oaks are the alternate host, isolation of pines from them would eliminate the danger. This course may not be practical, however, for the spores spread more than 1,800 feet. Ferbam sprays will control the disease but more economical methods are needed.

Muntz, H. H. 1947. PRESCRIBED BURNING OF LONGLEAF PLANTATIONS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 49.
Prescribed burning in a young longleaf pine plantation in central Louisiana reduced brown-spot infection and accelerated height growth.

Platt, W. D., Cowling, E. B., and Hodges, C. S., Jr. 1965. RESISTANCE OF CONIFEROUS ROOT WOOD AND STEM WOOD TO DECAY BY FOMES ANNOSUS. (Abstr.) Phytopathology 55: 130-131.
Decay resistance of sapwood from roots and stems of eight coniferous species was determined in a complete factorial experiment with 16 tissue isolates of Fomes annosus *from the same eight species.* Juniperus virginiana *was most resistant;* Pinus resinosa, P. virginiana, *and* P. palustris *were intermediate; and* P. echinata, P. elliottii *var.* elliottii, P. strobus, *and* P. taeda *were least resistant. Stem wood of all species was more resistant than root wood.*

Powers, H. R., Jr., and Boyce, J. S., Jr. 1963. ANNOSUS ROOT ROT IN EASTERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 76, 7 pp.
Covers distribution of Fomes annosus, *hosts, signs and symptoms, means of spread, type and extent of damage, and control. FA*

Siggers, P. V. 1945. CONTROLLING THE BROWN SPOT NEEDLE BLIGHT OF LONGLEAF PINE BY PRESCRIBED BURNING. AT-FA J. 8(1): 11. *Also in* Nav. Stores Rev. 55(25): 4, 8. *Also in* Forest Farmer 5(1): 8.
If infection averages 35 percent, fire should be applied in late winter after the second growing season. Value of the burn depends on size of area burned. A single 45-acre burn within an 800-acre area of badly infected seedlings was effective for only one growing season.

Snow, G. A. 1958. CULTURAL DIFFERENCES IN ISOLATES OF SCIRRHIA ACICOLA FROM PINUS PALUSTRIS AND P. TAEDA. (Abstr.) Phytopathology 48: 398.
No significant differences were found.

Snow, G. A. 1961. ARTIFICIAL INOCULATION OF LONGLEAF PINE WITH SCIRRHIA ACICOLA. Phytopathology 51: 186-188.
Longleaf pine was infected with Scirrhia acicola *isolated from loblolly as well as longleaf pine trees. About 8-11 weeks were required for expression of symptoms. Infection occurred only on immature longleaf needles 3-6 inches long, and not on loblolly pine. Cultural characters varied widely from isolate to isolate, and were instable following successive transfer. No correlation was found between cultural differences and percentage of infection, types of symptoms, or time of symptom expression on longleaf pine. Isolates from longleaf were, in general, more infective than those from loblolly.*

Snow, G. A. 1961. SEMICARBAZONE OF CYCLOHEXIMIDE FOR CONTROLLING BROWN SPOT NEEDLE BLIGHT. (Abstr.) Phytopathology 51: 645.
Early results warrant further tests.

Snow, G. A., Czabator, F. J., and Sorrels, S. S. 1964. CYCLOHEXIMIDE DERIVATIVES FOR CONTROLLING BROWN SPOT ON LONGLEAF PINE. U. S. Dep. Agr. Plant Dis. Reporter 48: 551-553.
One spray of semicarbazone or Bordeaux mixture in May or June gave significant control of Scirrhia acicola. *The Bordeaux mixture (4-4-50) was more effective than semicarbazone (25 p.p.m.), and methyl hydrazone (25 p.p.m.) was less effective than either. Semicarbazone gave better control at 50 p.p.m. than at 25. Infection on plants treated with the cycloheximide derivatives increased between 3 to 6 months after spraying.*

Thomas, A. A. 1956. THE CHRISTMAS EVE BURN. Amer. Forests 62(3): 28-29, 60. *Also in* U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 17(4): 9-12.
A prescribed burn to control brown spot in longleaf seedling stands was made on the Escambia Experimental Forest in south Alabama. The cost of the burn—including diagnosis, prescription, preparation, treatment, and appraisal—was less than $100. At least $2,000 worth of seedlings were saved.

Verrall, A. F. 1967. BROWN SPOT NEEDLE BLIGHT, SCIRRHIA ACICOLA (DEARN.) SIGGERS; (SYSTREMMA ACICOLA (DEARN.) WOLF AND BARBOUR). *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico, pp. 237-238. Can. Dep. Forest. and Rural Develop. Pub. 1180. *Also as* BROWN SPOT NEEDLE BLIGHT. *In* Important forest diseases of mutual concern to member countries of the North American Forestry Commission, pp. 64-65. Compiled by Working Group on Forest Insects and Diseases, N. Amer. Forest. Comm., FAO. 1963.
Distribution, hosts and description of damage, life history, and control measures. Problems of control have caused widespread planting of other pines on sites that formerly supported longleaf.

Verrall, A. F. 1967. SOUTHERN FUSIFORM RUST, CRONARTIUM FUSIFORME HEDGC. & HUNT EX CUMM. *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico, pp. 221-223. Can. Dep. Forest. and Rural Develop. Pub. 1180.
Longleaf is resistant to attack, and hence should be favored over other pines for planting in areas where the disease is severe.

Weber, G. F. 1943. NEEDLE RUSTS OF PINE TREES IN FLORIDA CAUSED BY COLEOSPORIUM SPECIES. Proc. Fla. Acad. Sci. 6: 131-142.
Each of the eight indigenous pines of Florida (Pinus australis, P. caribaea, P. clausa, P. echinata, P. glabra, P. palustris, P. serotina, *and* P. taeda) *is susceptible to infection by heteroecious needle-rust fungi of the genus* Coleosporium. *The alternate hosts of the fungi are generally broadleaved plants, a large number of which belong to the family Carduaceae. Infection of pine seedlings is widespread in Florida and occasionally severe enough to be of economic importance. Saplings up to 10 feet in height are also commonly infected, but, as a rule, the disease produces no serious effects at this stage. The symptoms of needle rust are described and the taxonomy and morphology of the causal fungi are discusssed. Attention is drawn to the development of the fungi in relation to their host plants. Control of the disease on pines can be brought about by the elimination of the alternate host or by spraying with a copper fungicide. FA*

Zak, B., and Bryan, W. C. 1963. ISOLATION OF FUNGAL SYMBIONTS FROM PINE MYCORRHIZAE. Forest Sci. 9: 270-278. (Abstr.) Phytopathology 52: 34. 1962.
Describes techniques that permitted isolation of fungal symbionts directly from mycorrhizae of southern pines, including longleaf.

45 DAMAGE BY ANIMALS: MAMMALS, BIRDS, INSECTS, OTHER

Allen, R. M., and Coyne, J. F. 1955. REDUCING LONGLEAF CONE LOSSES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 98.
In southern Mississippi, first-year cone losses were reduced by spraying with BHC. Most of the damage prevented was that from the cone beetle Ernobius granulatus. *Losses due*

to a pitch moth, possibly Dioryctria amatella, *were not reduced, presumably because of late first spraying.*

Allen, R. M., and Coyne, J. F. 1956. INSECT PROBLEMS IN FOREST-TREE GENETICS. J. Forest. 54: 193.
Spraying with 0.5 percent BHC in water emulsion in March, immediately after removing the pollination bags, and in April, June, and August, afforded considerable protection to first-year cones of P. palustris *and* P. elliottii, *which suffer damage attributed to the beetle* Ernobius granulatus *and to a less extent a pitch moth* Dioryctria amatella. *A pollen eater, bark weevils, and a beetle attacking seed trees, seedlings and grafts, some of which have been controlled with BHC, are mentioned. FA*

Arata, A. A. 1959. EFFECTS OF BURNING ON VEGETATION AND RODENT POPULATIONS IN A LONGLEAF PINE-TURKEY OAK ASSOCIATION IN NORTH-CENTRAL FLORIDA. Quart. J. Fla. Acad. Sci. 22(2): 94-104.
Vegetative development following a mid-winter burn in a longleaf pine-turkey oak (Pinus australis—Quercus laevis) *association is briefly traced. Wiregrasses* (Sporobolus *spp.) formed the major plant cover on the unburned area, but were removed from the burned section, and affected at least part of the rodent population. Comparison of trapping results prior to and following the burn, indicated that fire was not detrimental to the rodent population over the whole area, but caused a shifting of populations after the fire as a result of change in the habitat. Cotton rats* (Sigmodon hispidus) *moved from the burned to the unburned portions of the field following the burn whereas population densities of old field mice* (Peromyscus polionotus) *and Florida deer mice* (P. floridanus) *remained essentially at pre-burn levels within the burned portion.*

Bennett, W. H. 1961. COMMON INSECT ENEMIES OF PINES IN THE SOUTHERN UNITED STATES. J. S. African Forest. Assoc. 39, pp. 13-18.
Brief descriptions.

Bennett, W. H. 1966. PUPAL MORPHOLOGY OF EXOTELEIA CHILLCOTTI FREEMAN (LEPIDOPTERA, GELECHIIDAE). Proc. Entomol. Soc. Wash. 68(3): 181-183.
Pupal morphology of this needle miner, which attacks Pinus palustris, *is similar to that of* E. pinifoliella. *FA*

Bennett, W. H. 1967. DIELDRIN FOR PROTECTING DIRECT-SEEDED LONGLEAF PINES FROM THE WHITE-FRINGED BEETLE, GRAPHOGNATHUS PERIGRINUS (BUCHANAN). J. Econ. Entomol. 60: 1186.
Mortality of direct-seeded pines was reduced when 10 percent dieldrin granules were applied at the rate of 3 pounds technical per acre.

Boyer, W. D. 1958. LONGLEAF PINE ESTABLISHMENT AND FIRST-YEAR SURVIVAL UNAFFECTED BY MODERATE GRAZING. J. Forest. 56: 655.
The study was in south Alabama. Cattle stocking was one cow to 60 acres.

Boyer, W. D. 1958. LONGLEAF SEEDLINGS ENDURE MODERATE GRAZING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 113.
See entry above.

Boyer, W. D. 1964. LONGLEAF PINE SEED PREDATORS IN SOUTHWEST ALABAMA. J. Forest. 62: 481-484.
A 3-year study in southwest Alabama showed that predators caused 93 to 99 percent of the seed and seedling losses during the first 3 months after spot seeding in November. Predator pressure was about equal in forest stands, seed-tree stands, and clearcut areas except for one year when the seed crop was much better than the other two years. That year the losses in the stands were significantly lower than in the openings. Small mammals were responsible for an average of 58 percent of the losses for all years; birds plus large mammals, 33 percent; and insects, chiefly ants, 9 percent. Losses to mice peaked before seeds germinated. Losses to birds and large mammals occurred before, during, and after germination. Losses to ants peaked during germination. Losses to all predators virtually ended when primary needles emerged.

Boyer, W. D. 1964. LONGLEAF SEED LOSSES TO ANIMALS ON BURNED SEEDBEDS. U. S. Dep. Agr. Forest Serv. Res. Note SO-6, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Losses in well-stocked, second-growth stands (age 40 to 60 years) of southern Alabama were about the same on fresh fall burns as on old roughs, but worse on winter burns than on old roughs. Predators were mostly mice.

Boyer, W. D. 1967. GRAZING HAMPERS DEVELOPMENT OF LONGLEAF PINE SEEDLINGS IN SOUTHWEST ALABAMA. J. Forest. 65: 336-338.
After the seedlings' second year, grazing was by far the most serious cause of loss. Over 5 years, light grazing killed 23 percent of the trees and reduced rootcollar diameter growth of survivors by 13 percent.

DeBarr, G. L. 1967. TWO NEW SUCKING INSECT PESTS OF SEED IN SOUTHERN PINE SEED ORCHARDS. U. S. Dep. Agr. Forest Serv. Res. Note SE-78, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Two insects, Tetyra bipunctata *and* Leptoglossus corculus, *causing damage to seeds of* Pinus palustris *and* P. elliottii *have been found in north Florida.* T. bipunctata *nymphs and adults feed on the nearly mature second-year cones. Third-instar nymphs and the older stages of* L. corculus *feed upon the seeds of both pine species. FA*

Ebel, B. H. 1961. THRIPS INJURE SLASH PINE FEMALE FLOWERS. J. Forest. 59: 374-375.
Damage to cones and seed of slash and longleaf pine, formerly ascribed to various causes is caused by thrips.

Ebel, B. H. 1963. INSECTS AFFECTING SEED PRODUCTION OF SLASH AND LONGLEAF PINES; THEIR IDENTIFICATION AND BIOLOGICAL ANNOTATION. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-6, 24 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
An account of insects collected and reared in north Florida in 1956-60, with a habitat list, annotations on the insects, and a key to flower and cone damage to slash and longleaf pines. FA

Ebel, B. H. 1964. THE OCCURRENCE OF ERNOBIUS GRANULATUS LECONTE IN ABORTED FIRST-YEAR CONES OF LONGLEAF PINE. J. Forest. 62: 404-405.
In northeast Florida many dead first-year cones containing larvae of Ernobius granulatus *LeConte were observed. This paper presents data indicating that* E. granulatus *is a secondary invader in the already dead cones.*

Ebel, B. H. 1965. THE DIORYCTRIA CONEWORMS OF NORTH FLORIDA PINES (LEPIDOPTERA: PHYCITIDAE). Ann. Entomol. Soc. Amer. 58: 623-630.
Details the biologies of the three Dioryctria *coneworms as they occur in cones and vegetative parts of* Pinus elliottii *Engelm. and* P. palustris *Mill.*

Ebel, B. H. 1966. REARING AND OCCURRENCE OF XYELID SAWFLIES ON SLASH AND LONGLEAF PINES IN NORTH FLORIDA (HYMENOPTERA: XYELIDAE). Ann. Entomol. Soc. Amer. 59: 227-229.
Soil-filled clay pots, sunk in the ground, were used for rearing Xyela pini *Rohwer from mature larvae taken on slash pine, and* X. minor *Norton and* X. bakeri *Konow from larvae found on both slash and longleaf pine. Some individuals of* X. minor *and* X. bakeri *spent a second year as*

dormant larvae before pupating. Two discrete populations of adult X. pini *were noted in the field. One, in January, fed on pollen of slash pines, which produce pollen earlier in the season than other local pine species; the other, in the second half of February, fed on pollen of loblolly pines* (Pinus taeda). *None were found feeding on other pines that produce pollen at intermediate times.*

Freeman, T. N. 1963. TWO NEW SPECIES OF CONIFEROUS NEEDLE MINERS FROM LOUISIANA AND THE DESCRIPTION OF A NEW GENUS (LEPIDOPTERA: GELECHIIDAE). Can. Entomol. 95: 727-730.
Describes a new species of leaf miner, Exoteleia chillcotti, *that feeds on longleaf pine* (P. palustris *Mill.).*

Hopkins, W. 1947. HOGS OR LOGS? Southern Lumberman 175(2201): 151-153. *Also in* Nav. Stores Rev. 57(43): 12-13. 1948.
Free-ranging hogs uproot pine seedlings and chew the bark off the taproot. Longleaf pine is the most susceptible species, especially when in the grass stage.

Hopkins, W. 1947. PERHAPS THE HOG IS HUNGRY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 50. *Also as* HUNGRY HOGS? Forest Farmer 6(11): 5.
Longleaf pine seedling roots are a nutritious, but expensive, food for hogs. They are 85 percent starch with very little fiber. A hog can destroy 400 pine seedlings in a single day.

Hopkins, W. 1947. PIGS IN THE PINES. Forest Farmer 7(1): 3, 8. *Also in* Nav. Stores Rev. 57(48): 16-17. 1948.
A description of the central Louisiana woods hog and its management. Editor's note summarizes the damage hogs do to longleaf pine seed and seedlings.

Hopkins, W. 1947. PINEY WOODS HOG HUNT. Forest Farmer 7(2): 3, 7.
Narrative of a hog roundup in central Louisiana in 1947.

Hopkins, W. 1951. WOODS HOGS VS. PINE LOGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 14 pp.
Woods hogs cause great damage to Louisiana's longleaf pine forests.

Kowal, R. J. 1960. SOUTHERN PINE BEETLE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 49, 7 pp.
Distribution, hosts, life history, and control. Shortleaf, loblolly, Virginia, and pitch pines appear preferred over slash and longleaf pines.

Kowal, R. J., and Coyne, J. F. 1951. THE BLACK TURPENTINE BEETLE CAN KILL TREES. AT-FA J. 13(9): 7, 14-15.
Describes the beetle (Dendroctonus terebrans) *and its control with benzene hexachloride sprays. Two photos show beetle damage to longleaf pine.*

Langdon, O. G., and LeGrande, W. P. 1965. RODENT DEPREDATION—A DIRECT SEEDING PROBLEM. U. S. Dep. Agr. Forest Serv. Res. Note SE-39, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
In South Carolina, tree establishment one year after direct sowing of pine seed (mainly Pinus palustris), *unscreened against rodents, was not increased by pre-treatment with Arasan-75 plus endrin 25 W, at 2.6 percent and 2.0 percent of dry seed weight respectively, or anthraquinone plus endrin 25 W at 15.0 percent and 2.0 percent. Untreated but screened sowings gave 42.8 percent establishment, while unscreened sowings, treated and untreated combined, gave only 5.2 percent. Higher concentrations are being tested. Nearly all depredation was by rodents, probably mainly* Peromyscus maniculatus. *FA*

Linnartz, N. E., Hse, C. Y., and Duvall, V. L. 1966. GRAZING IMPAIRS PHYSICAL PROPERTIES OF A FOREST SOIL IN CENTRAL LOUISIANA. J. Forest. 64: 239-243.
Describes studies of the effect on soil properties of 10 years' spring and summer grazing by cattle on Pinus palustris *clear fellings of the* Andropogon *type in central Louisiana, for three grazing intensities: (a) ungrazed, (b) moderate, and (c) heavy. Results, tabulated for texture, moisture constants, specific gravity, bulk density, porosity, and percolation rate, showed that the compaction caused by (c) seriously reduced infiltration (from 1.86 to 0.77 inch per hour) and percolation (from 0.242 to 0.133 inch per hour at a depth of 12-16 inches). FA*

Maki, T. E., and Mann, W. F., Jr. 1951. SOME EFFECTS OF SHEEP GRAZING ON LONGLEAF PINE. J. Forest. 49: 278-281.
The open range in southern Mississippi tends to be an unfavorable environment for longleaf pine seedlings. One reason is the presence of the piney woods sheep—a nondescript offshoot of the Spanish Merino, introduced to this country some 375 years ago.

Mann, W. F., Jr. 1947. SHEEP DAMAGE TO LONGLEAF PINE SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 52. *Also in* Southern Lumberman 175(2201): 125. *Also in* Nav. Stores Rev. 57(37): 2.
During a recent 2-year test in south Mississippi, sheep grazing at a rate of 100 per 1,300 acres, on land stocked with 2- to 48-inch longleaf pine seedlings at 1,442 per acre, damaged 86 percent of all seedlings under 4 feet high. More than half the injured seedlings were browsed two or more times during the test, total height growth was 25 percent less than on ungrazed control plots, and more than 15 percent of the injured seedlings appear to be permanently deformed. Mortality was 4.6 percent compared with 2.3 percent in controls. FA

Meanley, B., and Blair, R. M. 1957. DAMAGE TO LONGLEAF PINE SEEDLINGS BY COTTON RATS. J. Forest. 55: 35.
Heavy damage by cotton rats (Sigmodon hispidus) *was found near Oakdale in central Louisiana, in the spring of 1956. About 10 percent of the seedlings on 400 acres were killed or injured by the rats. Prescribed burning is recommended to control damage found in late fall. Spring and summer damage will require control by use of poison baits.*

Meanley, B., Mann, W. F., Jr., and Derr, H. J. 1956. COTTON RATS DAMAGE LONGLEAF SEEDLINGS. Forests and People 6(4): 42-43.
See entry above.

Meanley, B., Mann, W. F., Jr., and Derr, H. J. 1957. NEW BIRD REPELLENTS FOR LONGLEAF SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 105. *Also in* The Unit, News Letter 66, p. 11. *Also in* U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 28, p. 8.
The bird repellent Morkit has been withdrawn from the U. S. market, but several other chemicals are good substitutes.

Merkel, E. P. 1963. A NEW SOUTHERN PINE TIP MOTH. J. Forest. 61: 226-227.
A new species of pine tip moth (Rhyacionia subtropica *Miller) was described in 1960. Its geographic distribution coincides closely with the range of slash pine and it is a potential pest of slash and longleaf pine plantations in the Deep South.*

Merkel, E. P., and Ebel, B. H. 1961. CONE AND SEED INSECTS AND THEIR CONTROL. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 137-141.
Some progress has been made in developing methods to

control slash and longleaf pine cone and seed insects. Hydraulic spray applications of 0.5 gamma BHC water emulsion have controlled Dioryctria *spp. The same emulsion failed to control* Laspeyresia anaranjada *but guthion shows promise. Flower thrips have been controlled with heptachlor.*

Morgan, E. 1952. IN A PIG'S EYE. Forests and People 2(2): 10-14.
Discusses damage to longleaf pine seedlings by hogs.

Neunzig, H. H., Cashatt, E. D., and Matuza, G. A. 1964. OBSERVATIONS ON THE BIOLOGY OF FOUR SPECIES OF DIORYCTRIA IN NORTH CAROLINA (LEPIDOPTERA: PHYCITIDAE). Ann. Entomol. Soc. Amer. 57: 317-321.
A study, mainly on Pinus palustris *and* P. taeda, *of four species whose larvae damage cones (particularly), terminal shoots, and the cambium of stems and branches.* D. amatella *was found on* P. palustris *and* P. taeda; D. disclusa *on these and on* P. virginiana; *and* D. zimmermani *and* D. clarioralis *on* P. taeda. *Some parasites of these cone moths are described. FA*

Peevy, F. A. 1953. HOGS STILL PREFER LONGLEAF. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 87. *Also in* Southern Lumberman 187(2345): 111. *Also in* Forests and People 4(1): 35. 1954.
In central Louisiana hogs destroyed 80 percent of the seedlings in 1 month in a 3,000-tree longleaf plantation. In a 2,500-tree slash pine plantation in the same hog pasture less than 1 percent of the trees were killed.

Ruehle, J. L. 1965. HOST RANGE STUDIES OF SEVERAL PLANT-PARASITIC NEMATODES FOUND IN SOUTHERN PINE FORESTS. (Abstr.) Nematologica, Leiden 11(1): 45.
In the pot tests described, Pinus echinata, P. elliottii *var.* elliottii *(1),* P. palustris *(2), and* P. rigida *(3) were excellent or good hosts for* Helicotylenchus dihystera; P. taeda *(4) and* P. serotina *(5) were poor hosts, and* P. virginiana *(6) and* P. strobus *(7) were not hosts.* Criconemoides xenoplax *reproduced well on (1), (4), and (5), and poorly on (3) which, with (6), was also a poor host for* Scutellonema brachyurum; *(4) was not a host for the last. Of several other species tested, only* Meloidogyne incognita *went through some stages of development on (3), (6), and (7). FA*

Smith, R. H. 1957. HABITS OF ATTACK BY THE BLACK TURPENTINE BEETLE ON SLASH AND LONGLEAF PINE IN NORTH FLORIDA. J. Econ. Entomol. 50: 241-244.
Dendroctonus terebrans *has some peculiarities possibly useful in its control. The investigation described showed that an average of five attacks per tree were made in the first month after attacks started, and these were confined to the basal 18 inches of the bole. Subsequent attacks, spread over 5-7 months with a peak in the second and third month, increase in number and in height up the bole, and eventually average 28 per tree, 85 percent of which are in the basal 36 inches and only 3 percent above 72 inches. The number of attacks increases with d.b.h., but the height distribution of attack is unaffected by diameter in the range 9 to 17 inches d.b.h. The habits of the beetle were the same on both hosts, and for tapped and untapped trees. FA*

Smith, R. H., and Lee, R. E. 1957. BLACK TURPENTINE BEETLE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 12, 7 pp.
The most severe attacks of the black turpentine beetle, Dendroctonus terebrans *(Oliv.), occur on slash pine, loblolly pine, and, to a lesser degree on longleaf pine. Methods of detection, life history, and control are discussed.*

Thatcher, R. C. 1960. BARK BEETLES AFFECTING SOUTHERN PINES: A REVIEW OF CURRENT KNOWLEDGE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 180, 25 pp.
Species characteristics, environmental influences on populations, predators and parasites, controls, research needs.

Wilkinson, R. C. 1964. ATTRACTION AND DEVELOPMENT OF IPS BARK BEETLE POPULATIONS IN ARTIFICIALLY INFESTED PINE BOLTS EXPOSED ON FIRETOWERS AND TURNTABLES IN FLORIDA. Fla. Entomol. 47: 57-64.
While uninfested bolts of longleaf and slash pine exposed on fire towers were not attacked, slash pine bolts artificially infested with ♂*s of* I. grandicollis *or* I. calligraphus *were attacked by* ♂*s and* ♀*s of the respective species up to at least 91 feet from the ground. The attraction of* ♀*s introduced into bolts appeared to be weaker, but it was not known whether they had already mated. In one test, longleaf pine logs artificially infested with* ♂*s of* I. calligraphus *retained their attraction for at least 3 weeks. FA*

Yates, H. O., III. 1962. INFLUENCE OF TIP MOTH LARVAE ON OLEORESIN CRYSTALLIZATION OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 174, 2 pp.
To discover whether the difference in physical state observed between the oleoresin exuded from shoots of different species of southern pine infested by Rhyacionia frustrana *and* R. rigidana *was due to different reaction to exposure or to some larval substance, 20 tips were cut from trees of four species. On half of them, large larvae were put into the oleoresin that had collected 2 hours after cutting. After 24 hours, the oleoresin on* Pinus echinata *and* P. taeda *with larvae had crystallized, while that on* P. palustris *and* P. elliottii *var.* elliottii *(two resistant species), and that on all uninfested tips, remained sticky. The difference could still be observed after 4 days. FA*

Yates, H. O., III. 1965. THE INFLUENCE OF OLEORESIN ON SOUTHERN PINE INJURY BY RHYACIONIA (LEPIDOPTERA, OLETHREUTIDAE). Diss. Abstr. 26: 567.
Pupal and adult characters for separating R. frustrana *and* R. rigidana *are outlined. Loblolly* (a) *and shortleaf* (b) *pines are seriously injured by these insects, oleoresin produced by these hosts crystallizing at the lesion, whereas that produced by slash* (c) *and longleaf pines remains sticky and prevents further injury. There is no preference for egg-laying between* (a) *and* (c), *but subsequent larval growth is faster on* (a), *and the last two instars, normally spent within the shoot, are rarely found on* (c). *Behavior of the larvae when they encounter sticky oleoresin is discussed and measurements of amount and weight of oleoresin exuding from the four pine species are compared. The ability of the insect to bring about accelerated oleoresin crystallization is considered to be the primary factor in successful attack. Loss of terpenes from exuding oleoresin is associated with crystal formation; oleoresin from* (c), *unlike that from* (a) *and* (b), *shows no loss of terpenes and does not crystallize. FA*

Yates, H. O., III. 1966. SUSCEPTIBILITY OF LOBLOLLY AND SLASH PINES TO RHYACIONIA SPP. OVIPOSITION, INJURY, AND DAMAGE. J. Econ. Entomol. 59: 1461-1464.
Oviposition and initial larval feeding (injury) by R. frustrana *and* R. rigidana *were found on neighboring* Pinus taeda (a), P. echinata (b), P. palustris (c), *and* P. elliottii (d). *Shoot and bud killing (damage) occurred mostly on* (a) *and* (b). *Studies on* (a) *and* (d) *showed that differential larval survival following oviposition and initial shoot feeding was responsible for differences in shoot and bud killing. FA*

46 DAMAGE BY MAN: LOGGING

Boyer, W. D. 1964. LOGGING DAMAGE TO LONGLEAF SEEDLINGS. J. Forest. 62: 338-339.
When medium longleaf pine overstories were clearcut, half the mortality in advanced grass-stage reproduction resulted directly from the logging and half occurred among apparently undamaged seedlings during the first year after logging. Total seedling losses were 51 percent when log landings were on the cut area, and 33 percent when they were located elsewhere.

Croker, T. C., Jr. 1956. LONGLEAF PINE SEEDLINGS DAMAGED WHEN SEED TREES ARE TRACTOR-LOGGED. J. Forest. 54: 401.
Though logging conditions were good, the stocking of longleaf seedlings in an Alabama forest was reduced from 83 to 76 percent, and many survivors were damaged. Those that had emerged from the grass were the most vulnerable.

5. FOREST MENSURATION. INCREMENT. STAND STRUCTURE. MAPPING

52 MEASUREMENTS: TREES AND STANDS

Afanasiev, M. 1958. SOME RESULTS OF THE USE OF THE BITTERLICH METHOD OF CRUISING IN AN EVEN-AGED STAND OF LONGLEAF PINE. J. Forest. 56: 341-343.
In cruising 296.4 acres of even-aged, 35-year-old, second-growth longleaf pine in south Mississippi, three methods of timber estimating were used (a) total enumeration of strips 1 chain wide; (b) 10 percent enumeration by 1/5-acre plots; and (c) angle-count cruising with points at the center of each 1/5-acre plot. The basal area obtained by the Bitterlich method (c) was within 1.5 percent of the actual basal area determined by (a), when the whole area was considered, but in individual compartments basal area errors ranged from −22.7 percent to + 103.8 percent. The accuracy of (c) compared favorably with that of (b). Cruising intensity by the Bitterlich method is discussed, with reference to the size of trees when using 3.00 diopter prisms. FA

Bennett, F. A. 1953. TOPWOOD VOLUME TABLES FOR SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 42, 2 pp.
Rough cordwood volumes for trees 9 to 18 inches d.b.h.

Bryan, M. B., and McClure, J. P. 1962. BOARD-FOOT AND CUBIC-FOOT VOLUME COMPUTING EQUATIONS FOR SOUTHEASTERN TREE SPECIES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 145, 10 pp
The equations presented are based on d.b.h. (or diameter 1.5 feet above butt swelling), estimated diameter under bark at the top of the lower stem section (the saw log portion of timber trees), and height to and from this point (to a 4-inch top diameter over bark). Constants are presented for 20 species. FA

Cooper, R. W., and Olson, D. F., Jr. 1958. VOLUME DETERMINATIONS FOR SECOND-GROWTH SLASH AND LONGLEAF PINE IN NORTHEAST FLORIDA. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 92, 11 pp.
Cubic- and board-foot volume tables. A combined variable D^2HF proved best (D = d.b.h., H = total tree height in feet, F = form class), but the use of the single variable D^2H did not appreciably reduce the coefficient of determination.

Croker, T. C., Jr. 1951. CHECKED YOUR POLE VOLUME TABLES LATELY? U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 75.
Local cubic- and board-foot tables were constructed from measurements on approximately 4,000 longleaf and slash pine poles cut in south Alabama. Volumes of poles derived from these tables were higher than volumes for identical poles shown in currently published tables.

Page, R. H., and Bois, P. J. 1961. BUYING AND SELLING SOUTHERN YELLOW PINE SAW LOGS BY WEIGHT. Ga. Forest Res. Counc. Rep. 7, 9 pp.
A study was made to determine the ratio of weight to volume of slash, loblolly, shortleaf, and longleaf pine saw logs in Georgia, and it is concluded that weight gives an accurate measure of cubic-foot volume and, within wider limits, of board-foot volume. Since board-foot volume is greatly affected by log size, weight conversions to board feet should be adjusted to allow for log size. FA

Scarbrough, N. M. 1953. LONGLEAF TOPWOOD VOLUME. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 83.
A sample of 114 tops left by two loggers in south Mississippi indicated that the amount of pulpwood in tops could be estimated from tree diameter by the formula: V (cubic feet, peeled) = 0.3 (d.b.h. −4).

Taras, M. A. 1967. WEIGHT SCALING: ITS PAST-PRESENT-FUTURE. Wood Measurement Conf. Proc. 1967: 143-156. Fac. Forest., Univ. Toronto Tech. Rep. 7.
The development of weight scaling of wood products in the United States, with particular emphasis on work in the South. Gives pound-per-cord equivalents, regression equations for estimating board-foot contents of logs from weight, and pound-per-M b.f. equivalents for numerous southern species including longleaf.

Todd, A. S., Jr. 1955. HOW MUCH WOOD IN A CORD OF PINE SLABS? U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 87, 1 p.
Tables for determining the volume (cubic feet) of bark-free wood in slabs from southern pine logs.

53 SPECIAL MEASUREMENTS

Evans, M. J. 1967. APPLICATION OF RANKED-SET SAMPLING TO REGENERATION SURVEYS IN AREAS DIRECT-SEEDED TO LONGLEAF PINE. M. F. Thesis. La. State Univ. Baton Rouge.
Ranked-set sampling gave an unbiased estimate of true population mean. Variance was significantly lower than for random sampling, but because the number of seedlings was small the ranked-set method did not materially improve efficiency of the survey.

McCormack, M. L., Jr. 1964. A STUDY OF TECHNIQUES FOR DETERMINING ROOT EXTENSION USING RADIOACTIVE TRACERS. Diss. Abstr. 25: 732-733.
A study to develop equipment and techniques was carried out in plantations or pure stands of longleaf or slash pine.

Minor, C. O. 1951. STEM-CROWN DIAMETER RELATIONS IN SOUTHERN PINE. J. Forest. 49: 490-493.

Linear regression equations have been prepared, describing the relations between d.b.h. and crown diameter for Pinus taeda *and* P. palustris *in southeastern Louisiana. High degrees of positive correlation were found for both species. The effect of stand density, in terms of trees per acre, upon the d.b.h. per crown-diameter relation was analyzed for* P. taeda, *and was found to be negligible for practical purposes, probably because of stabilization of basal area per acre within the saw log stands sampled. Some practical applications of these results to the interpretation of air photos are described. FA*

Snyder, E. B., and Allen, R. M. 1963. SAMPLING, NURSERY, AND YEAR-REPLICATION EFFECTS IN A LONGLEAF PINE PROGENY TEST. Forest Genet. Workshop Proc. 1962: 26-27. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm.
Ten-year results from a comprehensive test illustrated the possibility of error or inefficiency from unrepresentative sampling, persisting effects of nursery environment, and indiscriminate replication by years.

54 ASSESSMENT OF SITE QUALITY

Bennett, F. A. 1953. SITE INDEXES OF THE SOIL SERIES ON THE GEORGE WALTON EXPERIMENTAL FOREST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 34, 2 pp.
The site indexes show that the "drains" or poorly drained areas are the best sites for slash pine and that on identical soils slash pine has a higher site index than longleaf. FA

Coile, T. S. 1952. SOIL PRODUCTIVITY FOR SOUTHERN PINES. PART II OF II—LONGLEAF, SLASH AND POND PINES. Forest Farmer 11(8): 11-12.
Tables giving longleaf pine site index in relation to texture of the soil, moisture equivalents, and depth to mottling.

Cruikshank, J. W. 1954. SITE INDEX OF MAJOR PINE FOREST TYPES IN THE SOUTHEAST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 50, 1 p.
Gives site-index averages for longleaf and four other southern pines for Coastal Plain and Piedmont sites.

Hodgkins, E. J. 1956. TESTING SOIL-SITE INDEX TABLES IN SOUTHWESTERN ALABAMA. J. Forest. 54: 261-266.
Discusses the regression studies made on southern pine throughout the south-east in which environmental factors, notably soil properties, are related to site index, and tests them against the site indices established from height-growth in 24 stands in the upper and lower Coastal Plain of southwest Alabama. In each of these stands the selected factors, the (height-growth) site index, and the range of soil-site indices are shown and the two sets of indices are graphically compared for longleaf, slash and loblolly pines. It is concluded that these studies have yielded basic information of far greater value than the tables they have produced, the limitations of which are emphasized. They are no substitute for site indices based on height growth, which are particularly preferable when based on local and not on general height/age curves. FA

Hodgkins, E. J. 1961. ESTIMATING SITE INDEX FOR LONGLEAF PINE THROUGH QUANTITATIVE EVALUATION OF ASSOCIATED VEGETATION. Soc. Amer. Forest. Proc. 1960: 28-32.
In a test in southwest Alabama, the correlation between plant indicators and measured site index was significant.

Hodgkins, E. J., and Gemborys, S. R. 1966. EXPLORATORY WORK ON THE USE OF PLANT INDICATORS IN THE LONGLEAF AND LOBLOLLY PINE FORESTS OF ALABAMA. Bull. Ecol. Soc. Amer. 47(4): 192.
A site-quality scale, based on the abundance and cover of selected indicator plants (determined subjectively, but found sufficiently accurate when evaluated by objective methods) proved to be satisfactory in longleaf but of doubtful value in loblolly pine forests. FA

Johnson, E. W. 1962. AERIAL PHOTOGRAPHIC SITE EVALUATION FOR LONGLEAF PINE. Ala. Agr. Exp. Sta. Bull. 339, 26 pp.
In a trial in southern Alabama and northwest Florida site index could not be reliably estimated from aerial photographs.

Johnson, E. W. 1965. A SHORT-CUT METHOD OF ESTIMATING TREE SITE INDEX IN LONGLEAF PINE. J. Forest. 63: 195-200.
The method consists of obtaining and averaging indices of three to six trees of largest d.b.h. on a 0.2-acre plot.

Linnartz, N. E. 1961. PINE SITE INDEX IS RELATED TO SOIL CLASSIFICATION IN SOUTHEASTERN LOUISIANA. La. State Univ. LSU Forest. Notes 48, 2 pp.
A field guide for estimating the site index of longleaf, slash, and loblolly pines.

Linnartz, N. E. 1963. RELATION OF SOIL AND TOPOGRAPHIC CHARACTERISTICS TO SITE QUALITY FOR SOUTHERN PINES IN THE FLORIDA PARISHES OF LOUISIANA. J. Forest. 61: 434-438.
In southeastern Louisiana, depth to the least permeable layer in the soil profile, percent of sand in the subsoil, and the pH of the subsoil were related to the site index of loblolly pine. Site index of slash pine was related to depth to the least permeable layer, percent of sand in the topsoil and in the subsoil, and degree of internal drainage. Longleaf site index was related to the sand content of the subsoil, the slope, and the degree of surface drainage.

McClurkin, D. C. 1953. SOIL AND CLIMATIC FACTORS RELATED TO THE GROWTH OF LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 132, 12 pp.
Measurements were made on sample plots in 145 stands ranging from Mississippi to east Texas. Data on soils, position on slopes, percent slope, class of surface drainage, aspect and rainfall were analyzed statistically. The January-June rainfall was more important than any other single variable, and depth to the least permeable horizon was the most significant of the soil factors. A table is given for determining site index from these two factors. FA

McClurkin, D. C. 1954. ESTIMATING QUALITY OF LONGLEAF SITES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 89.
See entry below.

McClurkin, D. C., and Covell, R. R. 1965. SITE INDEX PREDICTIONS FOR PINES IN MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-15, 9 pp. Southern Forest Exp. Sta., New Orleans, La.
Prediction equations have been developed for loblolly pine on 12 soil groups, for shortleaf on seven groups, and for longleaf on six.

Ralston, C. W. 1951. SOME FACTORS RELATED TO THE GROWTH OF LONGLEAF PINE IN THE ATLANTIC COASTAL PLAIN. J. Forest. 49: 408-412.
A number of soil, vegetation and other factors were sampled on 303 areas of even-aged Pinus palustris *on the Atlantic Coastal Plain. Statistical analyses of the data indicated that age of stand, moisture equivalent of the B horizon, depth of soil to mottling (indicating poor drainage), stand density, resin tapping, and latitude, were significantly related to height growth. A rapid method for field estimation of site quality of Coastal Plain soils for longleaf pine is discussed. FA*

Silker, T. H. 1965. PLANT INDICATORS CONVEY SPECIES RANGE OF ACCOMMODATION AND SITE-SILVICULTURE-MANAGEMENT RELATIONS. Soc. Amer. Forest. Proc. 1964: 50-54.
Discusses and illustrates the uses of plant indicators on the basis of studies in the Lake States, ponderosa pine type of the Cascade Mountains of Oregon, and in the longleaf and pine-hardwood types of the Gulf Coastal Plain. FA

Wakeley, P. C., and Marrero, J. 1958. FIVE-YEAR INTERCEPT AS SITE INDEX IN SOUTHERN PINE PLANTATIONS. J. Forest. 56: 332-336.
The intercept was taken as the 5-year period during the first year of which the tree attained breast height, and was determined by counting the whorls of primary branches. The method is mainly for use with stands up to 20 years old. One of its advantages over the conventional total height-total age method of site evaluation is that age of the trees need not be known.

56 INCREMENT: DEVELOPMENT AND STRUCTURE OF STANDS

Bennett, F. A. 1963. GROWTH AND YIELD OF PLANTED CONIFERS IN RELATION TO INITIAL SPACING AND STOCKING. Soc. Amer. Forest. Proc. 1962: 22-26.
Yields from unthinned stands of Pinus elliottii, P. taeda, P. palustris, P. strobus, P. resinosa, *and* Pseudotsuga taxifolia *are remarkably similar in relation to spacing; at ages 20-35 years the yield from an initial 200 trees per acre was > 50 percent, and yield from 600 trees was 90-98 percent, of that from 1,000 trees per acre.*

Cruikshank, J. W. 1952. 10-YEAR DIAMETER GROWTH OF SELECTED TREE SPECIES IN SOUTH GEORGIA. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 20, 1 p.
Averages for longleaf pine and other softwoods in the Coastal Plain of Georgia.

Curlin, J. W., and Box, B. H. 1961. ESTIMATING PAST ANNUAL HEIGHT GROWTH OF SLASH AND LONGLEAF PINES FROM LENGTH OF INTERNODES. J. Forest. 59: 372-373.
The techniques, for use in young stands, involves measuring the distance between primary internodes, using an extendable (to 45 feet) aluminum pole with a tape attached to the top. Results obtained in two plantations, when compared with annual measurement data for the same trees, showed an average error of 8-3 percent of the mean annual height growth, and a standard error of 10-3 percent. FA

Farrar, R. M., Jr. 1967. HOW DOES YOUR LONGLEAF GROW? Southern Lumberman 215(2680): 126-127.
On average sites near-maximum volume growth probably can be attained at basal areas of 60 to 80 square feet per acre. Growth is strongly related to site quality.

Goggans, J. F., and Schultz, E. F., Jr. 1958. GROWTH OF PINE PLANTATIONS IN ALABAMA'S COASTAL PLAIN. Ala. Agr. Exp. Sta. Bull. 313, 19 pp.
Reports a study of the correlation of soils and other site factors with the height growth of 5- to 16-year slash, loblolly, and longleaf pine. Regression equations for estimating the height of the tallest trees were developed, and for 8- to 16-year longleaf pine age alone proved as good a predictor of height as any. In no case were mineral-nutrient element concentrations of the top 6-inch soil layer found to be closely correlated with height growth, either when considered alone or with soil physical and climatic variables held constant. Regression equations developed for estimating the merchantable volume in cords of rough wood per acre are also presented. FA

Hawley, N. R. 1952. RAPID GROWTH RATES OF LONGLEAF-SLASH PINE SAW TIMBER IN THE MIDDLE COASTAL PLAIN OF GEORGIA. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 17, 2 pp.
Understocked stands of small sawtimber on the George Walton Experimental Forest in south Georgia are increasing in board-foot volume at a calculated rate of 27 percent annually.

Judson, G. M. 1965. TREE DIAMETER GROWTH IN ALABAMA. U. S. Dep. Agr. Forest Serv. Res. Note SO-17, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Growth rates for 10 years of the major economic species are summarized by species, tree diameter class, site, and geographical area, on the basis of measurements of 2,872 trees in Alabama in 1951-53 and 1962-63. FA

Larson, R. W. 1957. HOW LONG DOES IT TAKE TO GROW PINE PULPWOOD OR SAWTIMBER IN NORTH CAROLINA? U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 106, 2 pp.
Average d.b.h. growth for longleaf, shortleaf, loblolly, Virginia, pond, and white pine in relation to age and site quality is given in a series of graphs. Values are based on analysis of forest survey data from 2,725 plots in North Carolina.

Smith, L. F. 1948. THIRTY-FIVE YEARS OF DEVELOPMENT IN SECOND-GROWTH LONGLEAF. Southern Lumberman 177(2225): 149-152.
A study of a typical second-growth longleaf pine (Pinus palustris) *stand, well stocked but untended, and about 35 years old, on the McNeill Experimental Forest in Pearl River County, Mississippi. Tables include average diameters and heights, basal area and volume of merchantable trees, average annual growth and stumpage value in the years 1928, 1933, 1938, and 1947, on four types of plot: (1) unburned and ungrazed, (2) unburned and grazed, (3) burned and grazed, and (4) burned and ungrazed. The annual burning definitely retarded growth; grazing did not. FA*

Smith, L. F. 1950. GOOD GROWTH FROM WELL-STOCKED LONGLEAF STANDS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 67. *Also in* Nav. Stores Rev. 60(9): 30. *Also in* Forest Farmer 9(10): 10. *Also in* The Unit, News Letter 33, p. 19. *Also in* J. Forest. 48: 851.
On a good site in south Mississippi, a well-stocked second-growth longleaf pine stand produced 40 cords per acre in 35 years. Growth estimates, based on these yields, indicate that this stand should produce as much in 70 years as virgin stands did in two centuries.

Smith, L. F. 1952. GROWTH OF RESIDUAL LONGLEAF PINE IN SOUTHERN MISSISSIPPI. J. Forest. 50: 132-133.
Analysis of 50 stems of longleaf pine, left standing after clear felling in 1902-03 as being too small and suppressed to be worth taking, confirmed previous findings that residual longleaf may be expected to recover after release. FA

Smith, L. F. 1953. LONGLEAF PINE CAN GROW FAST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 87. *Also in* Forests and People 3(4): 33. *Also in* Southern Lumberman 187(2345): 130.
Well-stocked longleaf pine stands on the McNeill Experimental Forest in south Mississippi produced 45.3 cords per acre, including 12,000 board feet of sawtimber, by age 42.

Swinford, K. R. 1960. RELATIONSHIPS BETWEEN VARIOUS MEASURABLE STAND FACTORS AND VARIATION IN BASAL AREA IN LONGLEAF-SLASH PINE FLATWOODS FORESTS OF ALACHUA COUNTY, FLORIDA. Diss. Abstr. 21: 284-285.
Data were obtained from 41 separate stands in random loca-

tions with a sampling percent of 22.2 for all stands. Variables found to be significantly correlated with the dependent variable (coefficient of variation in basal area per plot) were: mean basal area per acre, mean number of trees per acre, coefficient of variation in number of trees per plot, crown closure percent (measured from individual plots on vertical aerial photographs), coefficient of crown closure percent and percent of total diameter classes having $\geq$ *10 percent of the total number of trees.*

Taras, M. A., and Wahlgren, H. E. 1963. A COMPARISON OF INCREMENT CORE SAMPLING METHODS FOR ESTIMATING TREE SPECIFIC GRAVITY. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-7, 16 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Methods of predicting longleaf and slash pine specific gravity, by using all or part of increment cores from different locations in the stem, are listed in order of their relative precision. FA

58 SURVEYING

Willingham, J. W. 1957. ESTIMATION OF FOREST MANAGEMENT INVENTORY DATA FROM AERIAL PHOTOGRAPHIC MEASUREMENTS. Forest Sci. 3: 270-274.
Equations, obtained by multiple regression and claimed to be first of their kind, are presented to express Y_1, *radial growth in inches at breast height during the last 5 years:* Y_2 *age at breast height;* Y_3, *d.b.h. in inches; and* Y_4, *merchantable volume in cubic feet (none of which can be read directly from photographs) in terms of* X_1, *tree height in feet;* X_2, *crown diameter in feet;* X_3, *crown density percent; and* X_4, *trees per plot (all of which can be read from photographs). Four equations are given (significant at 1 percent level) for* Y_1 *and* Y_2 *in terms of* X_1 *and* X_2, *and for* Y_3 *in terms of* X_1, X_2 *and* X_4. *The fourth equation (for merchantable volume) is* $Y_4 = 114.0 + 1.111X_3 + 3.030X_1 + 2.375X_4$. *Assuming no bias in the residual variance, this equation allows of an actual volume estimate to an accuracy of 9.6 cubic feet from 29 photo plots with a fiducial probability of 95 percent. Accuracy of reading required is stated as* X_1, X_2 *and* X_3 *to 10 feet, 3 feet and 10 percent respectively and* X_4 *to within 20 percent of actual, indicating the need for a competent interpreter, good photographs, and a minimum scale of 1:15,840. Sources of error and limits of applicability are discussed. FA*

Willingham, J. W. 1957. THE INDIRECT DETERMINATION OF FOREST STAND VARIABLES FROM VERTICAL AERIAL PHOTOGRAPHS. Photogram. Eng. 23: 892-893.
See entry above.

6. FOREST MANAGEMENT

62 METHODS OF MANAGEMENT: REGULATION

Behre, C. E. 1945. GROWING STOCK, CUTTING AGE, AND SUSTAINED YIELD. J. Forest. 43: 477-485.
This paper points out that for a given level of output the required growing stock is a function of cutting age and may be expressed as a multiple of the yield. Growing stock ratios, deduced from available yield tables and assumptions as to average cutting age, are given for several species including longleaf pine. Other tables show adequacy of present total timber stands and of present sawtimber stand. The author's calculations indicate that, contrary to popular opinion, the growing-stock deficit in the East is most serious in southern pine. Comment by A. E. Wackerman argues that a 60-year rotation is longer than is necessary for southern pine, and that substitution of 50 or 40 years greatly reduces the apparent deficiency. FA

56 SPECIAL BUSINESS PROBLEMS: COSTS AND RETURNS

Chappelle, D. E. 1962. VALUE GROWTH OF PINE PULPWOOD ON THE GEORGE WALTON EXPERIMENTAL FOREST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 140, 14 pp.
A study in even-aged, naturally regenerated pulpwood stands of longleaf and slash pine in the Coastal Plain of Georgia. Volume growth and value growth percents were computed over a 5-year period by reference to d.b.h., crown ratio, crown class (dominant plus codominant, and intermediate plus suppressed) by site index classes of longleaf, and by mean stand d.b.h. for slash pine, so as to assist the application of the concept of financial maturity. FA

Croker, T. C., Jr. 1950. SMALL LONGLEAF TRACTS SHOW PROFIT. Forest Farmer 10(2): 12.
Forest products worth $967 were harvested from a 40-acre longleaf tract during the first 2 years of management. On a poorer tract $314 worth of products were harvested during the same period.

Croker, T. C., Jr. 1951. TREE CROP BOX SCORE. Ala. Lumberman 3(5): 18-19. *Also as* AN ANNUAL TREE CROP. Forest Farmer 10(8): 9.
Over a 3-year span, $330 above all expenses was earned by harvesting an annual tree crop from a 40-acre tract of longleaf pine.

Croker, T. C., Jr. 1953. RESULTS OF GOOD MANAGEMENT SEEM LIKE WOODLAND MAGIC. Southern Lumber J. 57(10): 76. *Also in* Ala. Lumberman 5(5): 33-34. *Also as* RETURNS FROM A LONGLEAF PINE WOODLAND. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 83.
Two thousand dollars worth of forest products have been removed from a 40-acre longleaf pine tract in 5 years.

Croker, T. C., Jr. 1953. SIX YEARS OF MANAGEMENT ON THE ESCAMBIA FARM FORESTRY FORTY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 4 pp. (Similar annual publications from 1954 to 1967.)
Annual costs and returns from intensive management of a typical 40-acre tract of longleaf-slash pine.

Croker, T. C., Jr. 1954. SEVEN YEARS OF MANAGEMENT ON THE ESCAMBIA FARM FORESTRY FORTY. AT-FA J. 17(2): 14.
In 7 years, $2,800 worth of products have been removed from a 40-acre tract. There is more and better timber now than when management began.

Croker, T. C., Jr. 1954. TRAIL BLAZING FOR LONGLEAF INVESTMENT OWNERS. Southern Lumberman 189(2369): 167-169.
A brief account of the Longleaf Investment Forest, a 640-acre area in south Alabama. The forest was established to determine the net returns that can be expected from an investment in longleaf timberland, managed to provide current revenue while improving stand condition.

Krinbill, H. R. 1955. AN ANALYSIS OF FACTS CONCERNING LONGLEAF PINE. Southern Lumber J. 59(6): 20, 22, 76.
The author states that longleaf pine, the slowest growing of the southern pines, cannot compete on the lumber markets with the other southern pines. Cutover lands should not be allowed to stay idle for 25 to 40 years. Accelerated activity in reforestation, including direct seeding to speed up the process, should start now.

8. FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Berkley, E. E., and Woodyard, O. C. 1948. CERTAIN VARIATIONS IN THE STRUCTURE OF WOOD FIBERS. Textile Res. J. 18: 519-525.
X-ray diffraction patterns were obtained from the fibers of Sequoia, Trochodendron, *and* Taxodium *root, and from* Pinus palustris *and* P. ponderosa *compression wood. Those from* Pinus *showed a random arrangement of fibers.*

Cole, D. E., Zobel, B. J., and Roberds, J. H. 1966. SLASH, LOBLOLLY, AND LONGLEAF PINE IN A MIXED NATURAL STAND; A COMPARISON OF THEIR WOOD PROPERTIES, PULP YIELDS, AND PAPER PROPERTIES. TAPPI 49: 161-166. *Also as* SLASH, LOBLOLLY, AND LONGLEAF PINE IN A MIXED STAND; A COMPARISON OF THEIR WOOD PROPERTIES. Eighth Southern Conf. on Forest Tree Impr. Proc. 1965: 136-141.
In a Georgia study, no significant differences were found between the species in outerwood specific gravity, moisture content, years of corewood formation, or cellulose content; such differences as were found (tracheid length, corewood specific gravity, and corewood holocellulose content) were of low magnitude. When these species were cooked under the same conditions, loblolly pine gave higher pulp yields than longleaf pine; within trees, bolt 1 (the butt bolt) gave lower yields than bolt 2; bolt 1 also gave pulps with a lower burst factor and had lower moisture content than bolt 2. There was an inverse relationship between specific gravity and moisture content but no relationship between specific gravity and green density. Trees with high specific gravity gave slightly higher pulp yields than trees with low specific gravity even when yields were computed on the basis of ovendry chip weights on a volume basis, trees with high specific gravity gave markedly higher pulp yields.

Doerner, K., Jr. 1964. SOME CAUSES AND EFFECTS OF HORIZONTAL DENSITY VARIATION IN TREE STEMS. Forest Sci. 10: 24-27.
A mathematical analysis showing that, in the transverse section of a stem, the perimeter bending stress varies as the distance from the section to the point of application of the horizontal force; as the force itself varies; and also as $1/r^3$ *of a section of radius r. In youth, the large section modulus required (because of the high ratio of height growth to diameter growth) is got by a combined radius and density increase. In old age, the modulus resulting from the excessive radius is too large for the moment produced, and thus is balanced by the production of new cells of lower density. This analysis shows that new perimeter wood tends throughout the tree's life to react efficiently to stress stimuli. FA*

Erdtman, H. 1943. TALLKARNVEDENS FENOLISKA SUBSTANSER. IV. [PHENOL SUBSTANCES OF HEARTWOOD OF PINE.] Svensk Papperstidn. 46: 532.
In this paper on membrane-forming substances some results are incidentally mentioned from a study of the heartwood of Pinus strobus, P. nigra, P. montana, P. banksiana, *and* P. palustris. *All appear to contain phenols of the 'pinosylvin' type, sometimes with phenolic substances belonging to other groups (flavones). FA*

Hamilton, J. K., Partlow, E. V., and Thompson, N. S. 1960. THE NATURE OF A GALACTOGLUCOMANNAN ASSOCIATED WITH WOOD CELLULOSE FROM SOUTHERN PINE. J. Amer. Chem. Soc. 82: 451-457.
A mixture of galactoglucomannans and araboxylans was extracted with 5 percent sodium hydroxide from wood cellulose produced from a combination of Pinus elliottii *and* P. palustris. *The structure of an acetone- soluble galactoglucomannan acetate separated from the mixture is discussed. FA*

Johnston, D. R. 1951. STRUCTURE DRAWINGS TO "SPECIMEN WOODS." Wood 16(10): 386.
Detailed drawings and descriptions of the wood of four species, including longleaf pine.

McNaughton, G. C. 1944. IGNITION AND CHARRING TEMPERATURES OF WOOD. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 1464, 3 pp
With prolonged exposure at all temperatures used there was a gradual darkening of the wood accompanied by loss of weight and shrinkage in the transverse dimensions. Chemical destruction was not associated with any one critical temperature. Samples changed color and characteristics but none ignited.

Marts, R. O. 1949. EFFECT OF CROWN REDUCTION ON TAPER AND DENSITY IN LONGLEAF PINE. Southern Lumberman 179 (2249): 206-209.
Presents the results of experiments begun in 1937 by the U. S. Forest Products Laboratory to study the relationship of crown size to wood formation in southern pines, especially its influence on springwood and summerwood proportions in the annual ring, and the distribution of each in the main stem. Crowns of five open-grown P. palustris *were reduced by more than three-fourths in March 1947, and further reduced in January 1938, March 1939, and April 1941. In February 1948 these, with controls, were felled and analyzed. The crown reduction had a marked effect in reducing the taper of the trunks from the base to about the lower limit of the crowns. The reduction was primarily due to changes in the springwood:summerwood relationships. The average springwood widths in pruned trees were proportionately less of the total ring width at lower levels, and proportionately more at 24½- and 36-foot levels. The greatest increase in specific gravity was found in the wood that was formed at ca. 8- and 12-foot heights after crown reduction. FA*

Marts, R. O. 1950. WOOD QUALITY OF BUD-PRUNED LONGLEAF PINE. Southern Lumberman 181(2273): 197-199.
A preliminary examination was made of longleaf pine about 20 years old, from a small plantation in southern Louisiana, to ascertain the effect of tree spacing and of annual removal of lower lateral buds and shoots, up to 15-20 feet, on the form of the trunk, the width of the annual rings, and the density of the wood. Clear wood without knots was formed in the trunk from the pith outwards for the entire pruned length; the few defects could have been avoided by greater care in pruning. The wood of five trees at 6 by 12 foot spacing (A) averaged 5.5 rings per inch at breast height and 0.54 specific gravity, and that of five trees at 4 by 6 foot spacing (B) 6.6 rings per inch and 0.52 specific gravity.

These specific gravity values are above the average for second-growth longleaf pine of similar ring width. Taper was less below lower crown limits for trees of (B) than of (A). Trees in this study had less taper than those pruned to a height of 30 feet. (A) had a somewhat higher specific gravity and a greater average diameter in the lower part of the trunk than trees of (B), but total height growth was greater in the latter. These early results indicate that green pruning up to a height of 20 feet did not harm later growth. FA

Marts, R. O. 1951. INFLUENCE OF CROWN REDUCTION ON SPRINGWOOD AND SUMMERWOOD DISTRIBUTION IN LONGLEAF PINE. J. Forest. 49: 183-189.

A study was made to determine the effect of reduction of crown size on tree growth, especially its effect on wood formation in longleaf pine (Pinus palustris). *Severe and continued reduction of the lower part of the crown resulted in greatly reduced ring width in the lower part of the trunk. Earlywood was reduced more than latewood at the lower levels, compared with controls. Higher in the tree, near the lower limit of the crown, proportions of early- and latewood varied much less. The reduced formation of early wood in the lower trunk of pruned trees persisted for several years. FA*

Mitchell, H. L. 1964. PATTERNS OF VARIATION IN SPECIFIC GRAVITY OF SOUTHERN PINES AND OTHER CONIFEROUS SPECIES. TAPPI 47: 276-283.

Southern pines showed major differences in specific gravity between species and, for all species, a strong trend towards increasing specific gravity from northwest to southeast in the southeastern States—a trend well correlated with warm-season rainfall. In southern yellow pines, tree age had the strongest effect on specific gravity. Other variables having a statistically significant effect include diameter, volume, basal area, growth rate, rainfall, latitude and longitude. Western species, especially Douglas-fir and ponderosa pine, appear to lack any strong patterns of variation with geographic location. For Douglas-fir, diameter, volume, volume/age ratio, and age have the most significant effects on specific gravity. FA

Mitchell, H. L. 1965. PATTERNS OF SPECIFIC GRAVITY VARIATION IN NORTH AMERICAN CONIFERS. Soc. Amer. Forest. Proc. 1964: 169-179.

Reviews the findings of a number of surveys of specific gravity in North American conifers made by the U. S. Forest Service and other organizations. FA

Mitchell, H. L., and Wheeler, P. R. 1959. WOOD QUALITY OF MISSISSIPPI'S PINE RESOURCES. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2143, 20 pp.

Slash, longleaf, shortleaf, loblolly and spruce pines were subjected to in situ *sampling, the main objects being: (1) to obtain better information on intrinsic wood quality of Mississippi pine resources; (2) to seek out living trees of superior wood quality, form and growth rate for breeding studies and nursery requirements; and (3) to study the effects of environmental factors on wood quality and to apply this information to the practical growing of higher-value trees. FA*

Neale, J. A. 1939. FIRE EXPOSURE TESTS OF LOADED TIMBER COLUMNS. Res. Underwriters' Lab. Bull. 13, 23 pp.

A report on tests made at the Chicago testing station of Underwriters' Laboratories Inc. using timber columns upon which a vertical load, in the form of a hydraulic press, was imposed during exposure to fire. In early tests failure occurred at the upper end of the column owing to rapid heating of the end in contact with a metal cap that was used; because of this local failure the full fire resistance of the timber cross-section was not developed. In more recent tests (using selected structural longleaf pine and Douglas-fir columns of 12 × 12 inch nominal cross section, in ordinary lengths) the ends were protected by reinforced concrete bearing caps of special design. These caps were found to protect adequately the upper ends of the columns, and the timbers sustained the fire and load tests for as long as 78-112 minutes. Failure was due to the weakening of the shaft portion of the column with the progressive charring or combustion of the wood. FA

Paul, B. H. 1958. SPECIFIC GRAVITY CHANGES IN SOUTHERN PINES AFTER RELEASE. Southern Lumberman 197(2465): 122-124.

Tests on longleaf, shortleaf, and loblolly pines showed good response in diameter growth, with sometimes an increase, sometimes a decrease, and sometimes a fluctuation of specific gravity, presumably depending on whether interacting factors (soil moisture, crown development, etc.) promote more early- or more latewood increment.

Paul, B. H., and Marts, R. O. 1954. CONTROLLING THE PROPORTION OF SUMMERWOOD IN LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 1988, 10 pp.

A fairly close correlation was found (1927-29) to exist between the current soil water supply and latewood formation in Pinus palustris *trees in the deep, sandy soils of the Choctawhatchee National Forest. There was distinct evidence that water regularly supplied throughout the growing season greatly increased the relative proportion of latewood in the growth rings. A complete fertilizer, without artificial irrigation, seemed to increase diameter growth slightly, more so in the earlywood than in latewood; a nitrate fertilizer increased the latewood to a greater degree. FA*

Paul, B. H., and Smith, D. M. 1950. SUMMARY ON GROWTH IN RELATION TO QUALITY OF SOUTHERN YELLOW PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. D1751, 48 pp.

Summarizes some research results obtained in studies with loblolly, longleaf, shortleaf, and slash pines, and based on mechanical tests of old-growth and second-growth specimens. A considerable population of trees was analyzed for specific-gravity variation, and for site and stand relationships. The results from the analyses include the influence of site, of soil moisture (including irrigation), of stocking, of thinning, and of released growth following logging, on the specific gravity and related properties of the wood. FA

Sakornbut, S. S. 1951. DIFFERENTIATION OF WOODS OF SOUTHERN PINES BY CHEMICAL MEANS. J. Forest. 49: 109-111.

As a result of a number of tests, it was concluded that variation in percent of mineral constituents of wood could not be relied upon to identify the various southern pines since such variation is due much more to site than to species. Heartwoods of Pinus palustris, P. caribaea, P. taeda *and* P. echinata *can be distinguished with a high degree of probability by absorption spectrophotometric determination in the ultra-violet region. For all species, heartwood can be differentiated from sapwood by the spectrophotometric method and also by color reaction with* $FeCl_3$. *FA*

Saucier, J. R., and Taras, M. A. 1966. WOOD DENSITY VARIATION AMONG SIX LONGLEAF PINE SEED SOURCES GROWN IN VIRGINIA. J. Forest. 64: 463-465.

After eight growing seasons one source, from Florida, had lower specific gravity and was less frost-resistant than the others.

Shelbourne, C. J. A. 1967. STUDIES ON THE INHERITANCE AND RELATIONSHIPS OF BOLE STRAIGHTNESS AND COMPRESSION WOOD IN SOUTHERN PINES. Diss. Abstr. 27B (12, Pt. 1): 4201.

Describes the techniques used for determining bole straightness (a) *(measured on a scale where the lowest values denote the straightest trees) and amounts of different intensities of compression wood* (b). *A study of eight trees showed a positive relationship of* (a) *with severe* (b), *and weak negative relationships of* (a) *with mild* (b). *An extensive study of the percent of* (b), (a), *specific gravity and growth rate in* Pinus elliottii, P. taeda, *and* P. palustris *showed moderate positive relationships of* (a) *with severe* (b), *and weak negative relationships of* (a) *with slight* (b). *Narrow-sense heritabilities of 0.95 for* (b), *0.73 for specific gravity, 0.34 for height, 0.28 for diameter and 0.05 for cellulose were found in 5-year open-pollinated progenies of* P. taeda, *and of 0.20 to 0.50 for* (a) *in* P. taeda, *age 18 months to 5 years, values varying with age and the straightness trait measured. These results suggest that the accepted hypothesis for the formation of* (b) *needs revision, and that the moderate heritability of* (a) *and the very high heritability of* (b) *should allow improvements in both properties by selection and breeding. FA*

Taras, M. A., and Saucier, J. R. 1967. INFLUENCE OF EXTRACTIVES ON SPECIFIC GRAVITY OF SOUTHERN PINE. Forest Prod. J. 17(9): 97-99.
With unextracted cores, wood substance was overestimated by 6.0 to 7.5 percent. The authors present equations for predicting specific gravity of extracted material from values determined on unextracted material.

Thomas, R. J. 1967. THE STRUCTURE OF THE PIT MEMBRANES IN LONGLEAF PINE: AN ELECTRON MICROSCOPE STUDY. Amer. Wood-Preserv. Assoc. Proc. 63: 20-28.
Detailed ultrastructure study, with 16 micrographs.

Thompson, N. S., Heller, H. H., Hankey, J. D., and Smith, O. 1966. THE ISOLATION AND THE CARBOHYDRATE COMPOSITION OF THE EPITHELIAL CELLS OF LONGLEAF PINE (PINUS PALUSTRIS MILL.). TAPPI 49: 401-405.
A differential oxidative degradation of the bonds joining structural units of wood to each other may be achieved if the reaction is carried out under very mild, though prolonged, conditions with sodium chlorite at pH 4. The aggregates of epithelial cells bordering the resin canals were isolated. Examination of these canals showed many objects to be included in them.

USDA Forest Products Laboratory. 1955. WOOD HANDBOOK. U. S. Dep. Agr., Agr. Handbook 72. See pp. 29-30, 49, 70, 83, 112, 315, 322, 431, 440.
Characteristics, shrinkage values, strength properties, and related data on the wood of longleaf and other southern yellow pines.

USDA Forest Products Laboratory. 1965. SOUTHERN WOOD DENSITY SURVEY: 1965 STATUS REPORT. U. S. Dep. Agr. Forest Serv. Res. Pap. FPL-26, 40 pp. Forest Prod. Lab., Madison, Wis.
Mean specific gravities by State Forest Survey unit, and diameter class for each of the four major southern pines.

USDA Forest Products Laboratory. 1967. FOREST PRODUCTS LABORATORY LIST OF PUBLICATIONS ON THE GROWTH, STRUCTURE, AND IDENTIFICATION OF WOOD. 34 pp.
Lists several publications that include information on longleaf pine.

Wahlgren, H. E., and Fassnacht, D. L. 1959. ESTIMATING TREE SPECIFIC GRAVITY FROM A SINGLE INCREMENT CORE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2146, 24 pp.
Describes tests made to determine how increment-core specific gravity at breast height correlates with that of cross sections at successive heights throughout the merchantable volume of southern pines. Pulpwood bolts ca. 5.4 feet long were cut progressively from base to a minimum top diameter of 3 inches from 100 trees each of longleaf, slash, loblolly, and shortleaf pines (diameter range 5 to 16 inches), and complete cross sections, 1 to 2 inches thick, were cut from the trees between each two consecutive bolts. The d.b.h. was measured, and increment core extracted at this position, and the length from bark to pith measured to within 0.01 inch. Computations made for the mean specific gravity of each bolt are described and simple regression equations are given for estimating specific gravity. Progressive decrease in specific gravity with increasing height was confirmed, and significant relationship of increment-core specific gravity at breast height to the mean specific gravity of the stem were found. Further work is needed (a) to develop optimum mensurational procedures for nondestructive determination of breast height segments of tree boles, and (b) on sampling of southern yellow pine forests to establish relationships between core sample and tree specific gravity for the full range of site, age, diameter, and specific gravity. FA

Wheeler, P. R., and Mitchell, H. L. 1959. SPECIFIC GRAVITY VARIATION IN MISSISSIPPI PINES. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 87-96. *Also as* U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2250, 10 pp. 1962.
Of the single variables tested to predict core specific gravity, the most important was the reciprocal of age. The four southern pines showed true variation in core specific gravity according to geographic location.

Wood, L. W. 1950. SOUTHERN PINE AND THE DENSITY RULE. Southern Lumberman 181(2273): 236-238.
The density rule as applied to southern yellow pines requires one-third summerwood and not less than 6 rings per inch, or one-half summerwood with no restriction on rate of growth, these characteristics to be estimated by visual inspection of the ends of the piece. Pieces meeting these requirements are given a working stress for structural design one-sixth higher than that for unclassified material. Bending tests at Madison show that for shortleaf and loblolly pines nearly all values below 6,000 pounds per square inch are eliminated by the density rule. In longleaf pine the selection is less effective, but a tendency to eliminate low-strength material is apparent. Results are shown in graphs. Figures are also given showing that the application of the density rule to working stresses excludes low values; the basic stress for clear wood from all southern yellow pines without density selection is 2,200 pounds per square inch, and with density selection 2,500 pounds per square inch. FA

84 PRESERVATION AND SEASONING

Anonymous. 1946. REPORT OF COMMITTEE 7-10—DIVERSIFIED USES OF TREATED WOOD. Amer. Wood-Preserv. Assoc. Proc. 42: 255-265.
Research on the acid resistance of wood has shown that the temperature of the acid is very important. Life of untreated wood decreases 5 to 6 days for every 1° C. rise in temperature of a 30-percent HCl solution. Above approximately 35° C. the use of material other than wood is advisable. Southern cypress and longleaf pine are the best species for use in contact with acid: Sitka spruce, redcedar, and redwood next. Within any species the higher the dry-weight density, the greater the resistance to HCl.

Cockrell, R. A. 1949. FURTHER OBSERVATIONS ON LONGITUDINAL SHRINKAGE OF SOFTWOODS. Forest Prod. Res. Soc. Proc. 3: 455-459.
Results of experiments on the longitudinal shrinkage of Pinus ponderosa, Abies concolor, Pinus echinata, P. palus-

tris, P. radiata, P. taeda, *and* Pseudotsuga taxifolia, *confirm earlier results on* P. ponderosa. *Summerwood strips elongate slightly in drying from green to air-dry and shorten appreciably in drying to oven-dry. Measurements on blocks showing growth rings of different widths do not cause excessive longitudinal shrinkage in the species studied. FA*

Davis, W. H., and Thompson, W. S. 1964. INFLUENCE OF THERMAL TREATMENTS OF SHORT DURATION ON THE TOUGHNESS AND CHEMICAL COMPOSITION OF WOOD. Forest Prod. J. 14: 350-356.
In tests on longleaf pine, Douglas-fir, and southern red oak, which had been subjected to schedules of oven-heating at 150-200° C. for 20-60 minutes or steaming at 126-148° for 30-120 minutes, oak proved the most responsive species. Steaming reduced toughness and carbohydrate contents more than oven-heating did. Physical and chemical changes were roughly proportional with time or temperature, and were also correlated with each other. Variations in hemicellulose content appeared to have a larger influence on strength than is generally assumed. FA

Koch, P. 1964. TECHNIQUES FOR DRYING THICK SOUTHERN PINE VENEER. Forest Prod. J. 14: 382-386.
In the trials described, cants of southern pine (loblolly, plus some shortleaf and longleaf), 4-12 inches square, were flat-sawn to simulate sliced 'veneers' 7/16 inch thick after surfacing, which were dried (a) *in the open air,* (b) *in a kiln at a maximum of 186° F.,* (c) *in a jet drier at 300°,* (d) *in a roller veneer drier at 300°, and* (e) *in a hotplate press, with ventilated cauls, at 300° and 82.6 pounds per square inch pressure. Of these methods* (e) *was fastest (23 minutes); it caused significant densification and thickness shrinkage, but little shrinkage in width and length, and gave the least distortion. Treatments* (c) *to* (e) *caused heavy resin exudations that would create difficulties in gluing unless removed by surfacing. Drying methods did not affect 'veneer' stiffness, and laminated beams made from 'veneers' dried by the different methods did not differ significantly in modulus of elasticity, modulus of rupture, or work to proportional limit. Treatment* (e) *appears best from a technical point of view, but economic considerations may favor* (b) *or* (c). *FA*

Lindgren, R. M., and Erickson, E. C. O. 1957. DECAY AND TOUGHNESS LOSSES IN SOUTHERN PINE INFECTED BY PENIOPHORA. Forest Prod. J. 7: 201-204.
In exploratory tests, barked longleaf bolts, stored during summer in Mississippi under conditions resembling commercial practice, showed symptoms of decay attributable to P. gigantea *in ca. 31, 58, and 62 percent of the cross section after respectively 6, 10, and 13 weeks. Corresponding mean losses in specific gravity were 0.6, 3.2 and 3.5 percent, and losses in toughness 16, 27 and 33 percent. Symptoms ranged from slight yellow discolorations in the early stages to softened patches of early wood after 13 weeks, but there were no open pockets. FA*

Page, R. H., and Perry, J. H., Jr. 1962. PRETREATING TURPENTINED LONGLEAF PINE POLES TO IMPROVE PENETRATION AND RETENTION OF CREOSOTE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 152, 13 pp.
Describes trials in which nearly 100 percent of bark-tapped, acid-treated longleaf poles showed adequate penetration and retention behind the face after air-drying to ca. 30 percent, incising, and steam conditioning. Slash pine generally required no incising. FA

Panek, E. 1957. PRESERVATIVE TREATMENT OF JACK PINE AND LONGLEAF PINE POSTS BY THE HOT-AND COLD BATH AND ITS BOILING-IN-WATER ADAPTATION. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2085, 10 pp.
Uninfected posts of both species showed low retentions and limited preservative penetration when given a hot bath for 1 hour and a cold bath for ½ hour. Preservative retention was more than sufficient and penetration was satisfactory when the hot bath lasted 1½ hours and the cold bath 2 hours. Mold infection caused excessive retentions in posts of both species. FA

Scott, M. H. 1946. THE USE OF CHEMICALLY TREATED WOODEN POLES FOR TELEPHONE AND POWER TRANSMISSION LINES IN SOUTH AFRICA. J. South Afr. Forest. Assoc. 13: 21-34.
The Forestry Department's plantations have provided excellent poles—including some of longleaf pine—from thinnings. FA

85 GRADING OF WOOD AND WOOD PRODUCTS

Anonymous. 1955. THREE NORTH AMERICAN "PINE" TIMBERS. Holz-Zentralbl. 81(114): 1355-1356.
A description of Pseudotsuga taxifolia, Pinus echinata *and* P. palustris, *including nomenclature, provenances, timber properties, uses and grading rules, preceded by a general explanation of North American log- and grading-rule principles. FA*

Campbell, R. A. 1962. A GUIDE TO GRADING FEATURES IN SOUTHERN PINE LOGS AND TREES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 156, 23 pp.
Describes and illustrates the degrading features—knots and large holes, excess sweep, and conks (Fomes pini *rot), the imperfections affecting log scale but not grade—cankers, crook and fork, insect and mechanical injuries, and other imperfections—compression wood, stain, etc. FA*

Campbell, R. A. 1962. OVERRUNS—SOUTHERN PINE LOGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 183, 2 pp.
Presents overrun and underrun data from a grade yield study of 1,491 logs of the four major species for logs 6-24 inches diameter under bark according to Doyle, Scribner, and International ¼-inch rules. The logs were cut in efficient mills with circular saws. FA

Campbell, R. A. 1962. SOUTHERN PINE LUMBER GRADE YIELDS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 182, 2 pp.
Presents, on the basis of mill studies in five States, tables for green lumber yields by grades for (a) *slash and longleaf pine (log grades II to IV, diameter under bark 10-16 inches), and* (b) *loblolly and shortleaf (grades I to IV, diameter under bark 6-20 inches. FA*

Campbell, R. A. 1964. FOREST SERVICE LOG GRADES FOR SOUTHERN PINE. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-11, 17 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Specifications of a southern pine log grade system adopted by the U. S. Forest Service after 30 years of research. Both green and dry lumber yields are shown by log grade and species group.

Campbell, R. A. 1964. SOUTHERN YELLOW PINE LOG GRADES. Southern Lumberman 209(2600): 28-30.
Sketches background of southern pine log grade development within the Forest Service. Lumber yields are shown by log grade, size, and species group, and the need for separate yields tables for loblolly-shortleaf and slash-longleaf is explained. Log grading specifications, grading procedures, and examples of uses and users of these log grades are presented.

86 PULP INDUSTRIES: CHEMICAL UTILIZATION OF WOOD

Anonymous. 1947. TURPENTINE RECOVERY IN PULP MILLS. Pulp Pap. Mag. Can. 48(7): 79-81.
Crude turpentine or pinene can be recovered from certain coniferous pulpwoods, particularly southern yellow pine (P. elliottii) *and longleaf pine* (P. palustris) *during the cooking period of a wood charge in digesters. The extent of recovery varies from 1½ to 4 gallons per ton of pulp produced, depending on the type, age, and provenance of the wood. Details are given for the design and operation of a unit for recovery of turpentine. FA*

Asunmaa, S., and Marteny, W. W. 1963. MORPHOLOGY OF REFINED PULPS OF SOUTHERN PINE (LONGLEAF PINE) AND BLACK ASH. TAPPI 46: 613-622.
Changes in the cellular structure of pulp fibers of longleaf pine and black ash in relation to the mechanical action of refining.

Gleaton, E. N., and Saydah, L. 1956. FIBER DIMENSIONS AND PAPERMAKING PROPERTIES OF THE VARIOUS PORTIONS OF A TREE. TAPPI 39: 157A-158A.
Experimental cooks of Pinus palustris *branchwood* (A), *stumpwood* (B), *rootwood* (C), *topwood* (D), *and centerlog wood* (E), *gave the following results (tabulated and graphed): the length of fibers decreased in the sequence B, E, D, C, A, the width of fibers in the sequence B, C, D, A, E; the length/width ratio and the pulp strength increased in the sequence A, B, C, D, E. FA*

Harris, E. E., Beglinger, E., Hajnay, G. J., and Sherrard, E. C. 1944. HYDROLYSIS OF WOOD IN A STATIONARY DIGESTER BY SUCCESSIVE TREATMENTS WITH DILUTE SULFURIC ACID. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. R1455, 34 pp. (Abstr.) Pulp Pap. Mag. Can. 45: 772.
Mill waste from 12 varieties of softwoods, four varieties of hardwoods, and the residue from the solvent extraction of longleaf pine stumps has been hydrolyzed in a pilot plant in 400-pound charges. Yields of total reducing sugars from softwoods such as Douglas-fir, spruce, and southern yellow pine range from 45 to 57 percent of the weight of the wood; from hardwoods such as oak and maple 45 to 52 percent; and from turpentine-spent chips 35 to 37 percent.

Jentzen, C. A. 1964. EFFECT OF STRESS APPLIED DURING DRYING ON SOME PROPERTIES OF INDIVIDUAL PULP FIBERS. Forest Prod. J. 14: 387-392.
Springwood and summerwood fibers of a longleaf pine holocellulose pulp were dried under various axial tensile loads. At commencement of drying, fibers underwent a sudden extension which was independent of the drying load. Drying under load caused an increase in Young's modulus, tensile strength, work-to-rupture, and crystallite orientation; it caused a decrease in ultimate elongation, and the crystallinity remained the same. In general, springwood fibers underwent much larger changes than summerwood fibers.

Jentzen, C. A. 1964. THE EFFECT OF STRESS APPLIED DURING DRYING ON SOME OF THE PROPERTIES OF INDIVIDUAL PULP FIBERS. TAPPI 47: 412-418.
See entry above.

Lawrence, W. P. 1947. CHLORITE BLEACHING OF SOUTHERN PINE KRAFT PULP. Pap. Trade J. 124(21): 38-40.
In specialized applications alkaline chlorite was very satisfactory as a finishing bleach for raising P. palustris *kraft pulp to G. E. brightness 80 to 83, with good retention of strength characteristics.*

Lehrbas, M. M. 1950. WOOD DENSITY INFLUENCES PULP YIELD. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 68.
The yield of screened kraft-type sulphate pulp that can be secured from southern pine wood of various densities has been determined by the Forest Products Laboratory, Madison, Wisconsin. Yields were found to increase from 10.2 pounds of pulp from 1 cubic foot of ovendry wood of 22 pounds per cubic foot density, to 17.4 pounds from wood of 36 pounds per cubic foot density. The approximate yield of moisture-free pulp per cubic foot of wood with any density from 22 to 36 pounds can be calculated by multiplying the density (in pounds per cubic foot ovendry) by 0.509 and subtracting 0.96 from the answer. The samples tested included Pinus taeda, P. palustris, P. echinata, *and* P. caribaea *varying in growth rate and in amounts of summerwood and compression wood. No correlation was found between yield percent (pounds of pulp per 100 pounds of wood) and density. FA*

Martin, J. S. 1962. KRAFT PULPING OF WEST FLORIDA SAND PINE AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2248, 12 pp.
Kraft pulps made from the open-cone form of Pinus clausa *were higher in overall strength and brightness than those made from* P. palustris *from the same area, and essentially equal to them in cooking conditions, bleaching requirements, and yields by weight.* P. clausa *pulps are therefore considered suitable for unbleached and bleached kraft papers of high strength. FA*

Skolnik, H., and Snow, A. G., Jr. 1946. RESIN IMPREGNATION OF CATFACES. Pap. Trade J. 122(12): 52-53.
Resin impregnation resulting from current turpentining practice renders the turpentined 'catface' portion of turpentine-producing pines undesirable for paper pulp, thus preventing full utilization of two of the most important southern species, slash and longleaf pine. Recent research has developed new methods which apparently do not increase the resin content of the butt log beyond the limits of acceptability for pulp. FA

Spiegelberg, H. L. 1966. THE EFFECT OF HEMICELLULOSES ON THE MECHANICAL PROPERTIES OF INDIVIDUAL PULP FIBERS. TAPPI 49: 388-396.
Several pulps differing in hemicellulose (h.c.) content were obtained from Pinus palustris *holocellulose pulp by selective alkaline extraction of latewood fibers. Measurements of elongation of fibers when dried under various loads or no load showed that removal of hemicellulose, besides making the fibers more crystalline, reduced breaking stress, modulus of elasticity, yield point stress and work-to-rupture of the fibers, but drying under load increased values for these properties. Evidence is presented indicating that the effect of hemicellulose content on fiber strength is to allow a greater internal redistribution of stress in fiber subject to external loads; removal of hemicellulose thus reduces flexibility and strength. A practical implication is that commercial pulps low in hemicellulose will tend to form papers differing appreciably in tensile properties in different directions, owing to large changes in fiber mechanical properties caused by drying under load. FA*

89 OTHER FOREST PRODUCTS: OLEORESIN

Clark, C. K., and Osborne, J. G. 1948. THE PROPERTIES OF LONGLEAF PINE OLEORESIN AS AFFECTED BY TREE CHARACTERISTICS AND MANAGEMENT PRACTICES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Tech. Note 70, 17 pp.
Tree factors studied were diameter, growth rate, and in-

herent yielding capacity. Management practices included frequency of dipping and height of face.

Fontes, L. F. 1954. PINUS CARIBAEA, MORELET, PINUS PALUSTRIS, MILLER: THEIR WOODS, CHEMICAL PRODUCTS, APPLICATIONS, STATISTICAL DATA. Serv. Florestal. do Estado. Sao Paulo, Ed. e Propag. 46, 15 pp.
In Portuguese.

Harris, G. C. 1948. RESIN ACIDS. V—THE COMPOSITION OF THE GUM OLEORESIN ACIDS OF PINUS PALUSTRIS. J. Amer. Chem. Soc. 70: 3671-3674.
The composition of the acid fraction has been determined fully for the first time with such techniques as the amine salt method. In addition to the already known levopimaric and dextropimaric acids and a dihydroabietic acid, the oleoresin contains neoabietic, abietic, isodextropimaric, and dehydroabietic acids.

Harris, G. C., and Sanderson, T. F. 1948. RESIN ACIDS. VII—ISOLATION AND STRUCTURE OF ISODEXTROPIMARINAL, A POSSIBLE RESIN ACID PRECURSOR. J. Amer. Chem. Soc. 70: 3870-3872.
The aldehyde of isodextropimaric acid, termed isodextropimarinal, has been isolated from the neutral fraction of both wood and gum rosins. Its identity was proved by oxidation with chromic acid to obtain the pure resin acid in good yield.

Joye, N. M., Jr., and Lawrence, R. V. 1966. PRESENCE OF SANDARACOPIMARIC AND $\Delta^{8(9)}$-ISOPIMARIC ACIDS IN PINE OLEORESIN. J. Organ. Chem. 31: 320-321.
Sandaracopimaric acid (a) *was previously known from pine heartwood extractives and* $\Delta^{8(9)}$*-isopimaric acid* (b) *from resins of* Tetraclinis *and* Callitris *spp. It was suspected that acid used in stimulating resin flow might have caused the isomerization of isopimaric acid to* (b), *but it proved to be present in the same quantity in resin from freshly streaked trees on which no acid had been used.* (a) *was found in all pine oleoresins and rosins examined, and varied from 0.7 to 2.5 percent by weight of the sample.* (b) *was found in all samples of slash and longleaf pine resin and rosin. In most rosins it amounted to* < 1 *percent of the acid fraction but in a sample from* Pinus edulis *it was the major component* (> 30 *percent). FA*

Loeblich, V. M., Baldwin, D. E., and Lawrence, R. V. 1955. THE ISOLATION OF A NEW RESIN ACID FROM GUM ROSIN-PALUSTRIC ACID. Amer. Chem. Soc. J. 77: 2823-2825.
A new primary acid of the abietic type, named palustric acid, has been isolated from gum rosin by means of partition chromatography. The presence of this acid in the oleoresin of Pinus palustris *and* Pinus caribaea *has been established. The physical constants and ultraviolet absorption spectrum have been obtained. Palustric acid has been isolated as an intermediate product in the acid and heat isomerization of levopimaric acid to abietic acid.*

Mellan, I., and Lubowe, I. I. 1959. SANITIZERS BASED ON PINE OIL. Soap and Chem. Spec. 35(4): 74-75, 79, 105.
Outlines the commercial uses of pine oil as an emulsifying, wetting, and dispersing agent, a penetrant and an activator of pesticidal and germicidal properties in such formulations. Chipped stumps of Pinus palustris *are processed by (1) steam distillation, (2) destructive distillation, and (3) extraction. The oily layer appearing after (1) is fractionated to obtain pine oil and wood turpentine oil, and the chips are further treated with solvent to extract more pine oil, turpentine, and rosin by fractional distillation. Apart from the commercial significance of the oil* per se, *the mechanical extraction of the slow-rotting resinous stumps has also alleviated the formerly chronic problem of land clearance in pine forests of the southern U.S.A. FA*

Mims, L. W., and Schopmeyer, M. C. 1947. PROPERTIES OF OLEORESINS, ROSINS AND TURPENTINES FROM CHEMICALLY STIMULATED SLASH AND LONGLEAF PINE. Ind. Eng. Chem. 39: 1504-1506.
The chemicals used to stimulate the flow of oleoresins were 25 percent NaOH, 24 percent HCl, and 40 percent and 60 percent H_2SO_4. *The results of the tests on oleoresins, turpentines, and resins are tabulated. There was no significant effect on either oleoresins or turpentines with any of the chemicals; neither HCl nor NaOH treatment affected resin color or transparency but 60 percent* H_2SO_4 *caused slight darkening of color and both 40 and 60 percent some clouding in the resin. FA*

Mirov, N. T. 1961. COMPOSITION OF GUM TURPENTINES OF PINES. U. S. Dep. Agr. Tech. Bull. 1239, 158 pp.
Comprehensive treatise. Describes factors affecting variability of composition, and methods of chemical analysis. Presents physical and chemical data for 94 species.

Runckel, W. J., and Knapp, I. E. 1946. VISCOSITY OF PINE GUM. Ind. Eng. Chem. 38: 555-556.
Samples of three varieties of pine gum—slash gum, longleaf gum, and longleaf scrape—were diluted with freshly distilled gum turpentine (density 0.8605 at 26.8° C.) to concentrations of 25, 30, 35, and 40 percent turpentine by weight. Viscosities were then determined in a Stormer viscometer. FA

Schuller, W. H., Minor, J. C., and Lawrence, R. V. 1964. PHOTOSENSITIZED OXIDATION OF PINE GUM TO YIELD PEROXIDES. Ind. Eng. Chem. 3: 97-100.
Describes commercially promising tests with crude resin and rosins of slash and longleaf pine, yielding chiefly a mixture of peroxides from laevopimaric, palustric, and neoabietic acids. The derivation product from abietic acid gave a labile diperoxide. FA

9. FORESTS AND FORESTRY: NATIONAL VIEWPOINT

90 GENERAL: PROGRAMS, HISTORY

Anonymous. 1948. THE SOUTHERN RAILWAY'S DEMONSTRATION FOREST. Southern Lumberman 176(2212): 46, 48.
The Railway Lincoln Green Demonstration Forest near Dorchester, South Carolina, is designed to give object lessons to landowners in the management of pine. The forest is composed mainly of Pinus palustris, *with some* P. taeda *and about 600 acres of* P. elliottii.

Brown, C. L. 1964. THE PLACE OF LONGLEAF PINE IN SOUTHERN FOREST MANAGEMENT. Forest Farmer 24(3): 6-8, 16, 18-19.
Longleaf pine has many desirable traits but has been shunned because of its seedling growth habit and difficulty of regeneration. New nursery and planting techniques may increase longleaf's importance in the forest economy of the South.

Cassady, J. T. 1951. RESEARCHERS STUDY LOUISIANA'S CUTOVER PINELAND PRODUCTION. Forests and People 1(3): 18-20.
At Alexandria, Louisiana, Forest Service research is concentrated on cutover longleaf pineland.

Chapman, H. H. 1951. AN ANCIENT AND ORIGINAL TRANSPORTATION SYSTEM FOR LOGS IN SOUTHERN ALABAMA. J. Forest. 49: 209-210.
Virgin longleaf timber in southwest Alabama and northwest Florida was logged to the mill with a unique system of board flumes constructed in small streams. Remains of the flower can still be seen.

Craig, R. B. 1949. THE MAJOR FOREST ECONOMIC PROBLEMS IN THE LONGLEAF-SLASH PINE-CYPRESS REGION. Southern Pulp and Pap. Manufacturer 12(8): 38, 40, 42, 50.
In the flatwoods of northeastern Florida and southern Georgia the main problems are: the integration of timber naval stores, and cattle production; reforestation of denuded areas; and control of fire.

Croker, T. C., Jr. 1962. LONGLEAF PINEY WOODS LABORATORY. Ala. Forest Prod. 5(10): 17, 19-20.
The Escambia Experimental Forest is a 3,000-acre field laboratory in south Alabama where research on longleaf pine has been conducted since 1947. The objective is to solve critical problems in regeneration and stand management.

Croker, T. C., Jr. 1963. CHALLENGE OF THE BRANCH BOTTOMS IN THE LONGLEAF FORESTS OF SOUTH ALABAMA. J. Ala. Acad. Sci. 34: 138-139.
South Alabama's longleaf forests are interlaced with narrow branch bottoms which occupy one-fifth of the gross longleaf area and probably account for a third of its total potential productive capacity. Improved management of these areas would add several million dollars annually to the economy of the region.

Dorman, K. W. 1966. FOREST TREE IMPROVEMENT RESEARCH IN THE SOUTH AND SOUTHEAST. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-22, 90 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
The amount and scope of research with both softwoods and hardwoods are reported for 36 agencies or combinations of agency and geographic location. There are 305 projects or studies involving 20 forest tree genera and 39 research subjects. Of all investigations, 65 percent are with the genus Pinus, *4 percent with other softwoods, and 31 percent with some 15 hardwood genera. Of the work with* Pinus, *9 percent involves shortleaf pine, 27 percent slash pine, 9 percent longleaf pine, 26 percent loblolly pine, and 29 percent eight other pine species.*

Gaines, E. M. 1947. BREWTON BRANCH SERVES LONGLEAF PINE TYPE. Forest Farmer 6(8): 4.
The Forest Service, USDA, established a longleaf pine research center at Brewton, Alabama, on November 1, 1946.

Gaines, E. M. 1949. FOREST STUDIES IN SOUTH ALABAMA. Forest Farmer 8(5): 11, 14.
Describes longleaf pine studies on the Escambia Experimental Forest.

Gaines, E. M. 1952. MANAGEMENT PROBLEMS OF SECOND-GROWTH LONGLEAF PINE FORESTS. J. Ala. Acad. Sci. 21: 23-26.
A general discussion of assets, problems, and management practices.

Hawley, N. R. 1947. RESEARCH IN THE LONGLEAF-SLASH PINE BELT. Forest Farmer 6(11): 4-5.
General discussion of research to be conducted on the George Walton Experimental Forest in south Georgia by the Cordele research center of the Forest Service, USDA.

Henry, B. W. 1957. BETTERING NATURE'S BEST. Forest Farmer 17(2): 10-11.
The Institute of Forest Genetics, maintained by the Forest Service, USDA, at Gulfport, Mississippi, aims to improve the characteristics of longleaf, slash, loblolly, and shortleaf pines through selection and hybridization.

Hickman, N. 1962. MISSISSIPPI HARVEST: LUMBERING IN THE LONGLEAF PINE BELT, 1840-1915. 306 pp. Univ. Miss.
Also as HISTORY OF FOREST INDUSTRIES IN THE LONGLEAF PINE BELT OF EAST LOUISIANA AND MISSISSIPPI, 1840-1915. Diss. Abstr. 20: 652. 1959.
History of lumbering and naval stores operations in the longleaf belt of Mississippi and east Louisiana.

Jones, E. P., and Bennett, F. A. 1965. TEN YEARS OF TIMBER MANAGEMENT IN THE MIDDLE COASTAL PLAIN OF GEORGIA. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-16, 17 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Discusses management practices, growth, costs, and returns on a 2,300-acre demonstration forest of slash and longleaf pine. Notes changes on stand composition.

Kerr, E. 1954. DIAMONDS IN THE ROUGH. Forests and People 4(3): 7-15.
Naval stores from stumps of Pinus palustris *in Louisiana.*

Kerr, E., and Morgan, E. 1954. THE PROBERS OF PALUSTRIS. Forests and People 4(1): 21-29.
A popular account of research by the Forest Service, USDA, Alexandria, Louisiana.

Leard, H. H. 1963. THE HERESY OF ISAAC HOUSTON BASS. Amer. Forests 69(9): 20-21, 64.
Experiences of Houston Bass, Bass Pecan Company, in restoring longleaf pine to cutover land in south Mississippi.

Lemmon, R. S. 1948. THE BEST-LOVED TREES OF AMERICA. Home Gard. 11(1): 51-58.
A tribute to the esthetic qualities of individual trees and forest stands of longleaf pine and red oak.

McCrary, R. M. 1959. SAGA OF TWO PINES. Forest Farmer 19(2): 14.
An imaginative account of the lives of two old-growth pines —one a longleaf, the other a loblolly—that grew near Fort Gordon, Georgia.

McCulley, R. D. 1945. FOREST MANAGEMENT TRENDS IN THE NAVAL STORES REGION. Southern Lumberman 171(2153): 220, 222, 224.
Two practices that have been accepted as good business are improvement cutting and conversion to slash pine. Though less resistant to fire than longleaf, slash bears seed more often and in greater abundance. It is a better naval stores producer, tolerates more competition, and is almost unaffected by brown spot.

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Performance of Southern Pine Hybrids in South Mississippi

Dan Schmitt

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director

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Performance of Southern Pine Hybrids in South Mississippi

Dan Schmitt [1]

Interspecific hybridization was probably first scientifically studied by Kolreuter in the 18th century. Although the principal laws elucidating the nature of heredity had yet to be discovered by Mendel, and subsequently independently rediscovered early in the 20th century, interest in hybridization remained high in the intervening years because it was often observed that hybrid progeny exceeded both parents in vigor or expression of other characters. This phenomenon, known as heterosis, is still not completely understood, but it has interested tree breeders greatly and influenced their efforts. The goal is improved vegetative vigor, and one of the means to achieve it is quite logically assumed to be interspecific hybridization.

Among the major southern pines, the first hybrid reported was Sonderegger *(1)*, apparently a natural cross between longleaf and loblolly. The first southern pine hybrid to be produced by controlled pollination probably was a longleaf × slash cross made at the Southern Forest Experiment Station in 1929 by P. C. Wakeley *(13)*.

Subsequently the possibilities of interspecific pine hybridization were intensively studied at the Institute of Forest Genetics, Forest Service, Placerville, Calif. Interest was high; foresters and many early breeders confidently expected to take advantage of heterotic growth that would follow hybridization.

These early studies resulted in information on crossabilities *(2)*, taxonomic relations among species *(4)*, and juvenile performance *(5, 12, 15)*. They also yielded hybrid analyses and descriptions *(11)*. By 1959 interest in interspecific hybrids had become worldwide; the rather extensive literature was reviewed by Schütt *(14)*. There have been few creditable reports, however, of heterotic growth. Most tests report results from seedling and sapling progeny derived from crosses with pollen mixes.

During the late 1950's the Southern Forest Experiment Station and cooperators attempted an extensive series of interspecific pollinations at Alexandria and Many, La., and Gulfport, Miss. The hybrid seed was germinated, and local field tests of most of the possible southern pine hybrids were established.

[1] Plant Geneticist at the Institute of Forest Genetics, Southern Forest Experiment Station, Gulfport, Miss.

Good performance of 7-year-old longleaf × slash hybrids has been reported from the Louisiana plantings *(3)*, especially as regards resistance to fusiform rust *(Cronartium fusiforme* Hedgc. and Hunt ex Cumm.). The present paper provides information about the performance of six southern pine hybrids and various backcross combinations planted on at least two different sites in south Mississippi. The plantations range in age from 6 to 8 years. In many cases comparisons between hybrid families are possible.

The Plantations

The plantations, all on the Harrison Experimental Forest in south Mississippi, were established at different times and for different purposes, but collectively they provide a perspective of southern pine hybrid performance under a variety of local conditions. For convenience the plantations are designated A, B, C, and D. Table 1 summarizes information on age, site, replication, and culture (if any). Soil series were determined from a Soil Conservation Service map of the experimental forest (plantation C was not mapped). Soil moisture and site ratings are subjective; they were made when the plantations were established. The plantations collectively include six pines and their hybrids: longleaf *(Pinus palustris* Mill.), slash *(P. elliottii* Engelm.), loblolly *(P. taeda* L.), shortleaf *(P. echinata* Mill.), pond *(P. serotina* Michx.), and pitch *(P. rigida* Mill.). The last two species, and their hybrids with native southern pines, appear in plantation D only.

Information from each planting includes survival, height, and incidence of fusiform rust (tables 2-4). In addition, 4-year height growth is available from plantings A and B. Statistical evaluations of the data were made wherever possible; unless otherwise noted, significance is reported at the 0.05 probability level. Plantations A and C provide more reliable data than the others because of better replication (table 1), and they are of particular interest because many of the entries represent progenies from different seed and pollen parents.

Effect of Site and Culture

Both site and cultural conditions (including spacing) markedly affected height growth. In plantation A, where the noncontiguous blocks range from well drained to dry, there were significant between-block differences in height for longleaf and Sonderegger entries (including species hybrids of longleaf), but little evidence of changes in ranking among entries. Slash pine and its hybrids appeared unaffected by site differences.

Table 1.—*Age and site conditions of pine hybrid plantings in south Mississippi*

Plantation	Years in field	Spacing	Replications	Site			Culture [1]
				Soil series	Moisture condition	Rating	
		Feet					
A	8	12 × 12	3				
			I	Ruston	Moderately well drained	Fair	1.
			II	Ruston	Moderately well drained	Fair	
			III	Ruston	Excessive drainage	Poor	
B	8	6 × 6	None	Ruston	Excessive drainage	Poor	3.
C	6	6 × 12	7	?	Moderately well-drained abandoned field	Good	2.
D							
1	6	8 × 8	[2] 2-10	Bowie & Shubuta	Wet	Poor	2.
2	6	8 × 8	[2] 2-10	Ruston	Well drained	Fair	2.

[1] 1. Disking before planting, initial fertilization, spray first 2 years to control insects and brown spot, and annual mowing.
2. Disking before planting and annual mowing.
3. No treatment except clearing before planting.

[2] Single-tree plots in both plantings; number of replications per entry varies.

Table 2.—*Performance data from three plantings of southern pines and pine hybrids in south Mississippi*

Species or species hybrids	Source	Trees surviving	Survival	Mean height	Incidence of fusiform rust[1]
		No.	*Percent*	*Feet*	*Percent*
		PLANTING A			
Species					
Loblolly [2] (4-1)	Local	44	89	29.9	34
Loblolly (2-5)	"	30	88	29.2	60
Loblolly (2-6)	"	42	90	28.1	64
Slash (2-3×1-4)	"	45	92	27.5	60
Slash (1-4)	"	24	80	26.9	62
Slash (2-4)	"	43	75	26.5	58
Slash (1-4×2-3)	"	27	96	27.0	70
Slash (2-3)	"	41	85	26.4	63
Longleaf (5-2)	"	40	81	22.9	0
Longleaf (1-18)	"	25	100	22.7	4
Shortleaf (6-3)	"	45	83	18.4	0
Species Hybrids					
Slash (2-4) × loblolly (6-1)	"	47	46	26.0	100
Longleaf (5-2) × slash	"	21	86	25.7	0
Shortleaf (6-3) × loblolly	"	46	94	25.1	2
Shortleaf (6-3) × slash	"	39	65	24.8	5
Slash (2-3) × loblolly (6-1)	"	47	44	23.7	100
Loblolly (2-5) × Sonderegger (1-17)	"	46	87	28.9	85
Loblolly (2-5) × Sonderegger (2-7)	"	34	60	27.9	53
Loblolly (4-1) × Sonderegger (2-7)	"	43	83	27.1	60
Loblolly (2-6) × Sonderegger (2-7)	"	40	74	25.5	77
Sonderegger (2-7) × loblolly	"	46	52	26.2	35
Loblolly (2-6) × Sonderegger (1-17)	"	35	69	26.1	80
Sonderegger (2-7)	"	46	87	25.8	61
Sonderegger (1-17)	"	18	71	25.1	33
Sonderegger (2-7) × (shortleaf × slash)	Local & Calif.[3]	20	95	25.7	50
Longleaf (5-2) × Sonderegger (2-7)	Local	46	98	25.3	5
Longleaf (1-18) × Sonderegger (2-7)	"	23	96	25.5	30
Shortleaf (6-3) × (shortleaf × slash)	Local & Calif.[3]	31	94	24.5	6

Sonderegger (1-17) × (shortleaf × slash)	Local & Calif.[3]	23	58	20.2	57
	PLANTING B				
Species					
Loblolly (4-1)	Local	60	94	22.7	16
Slash (2-4)	"	59	92	19.6	25
Longleaf (5-2×5-1)	"	26	93	17.3	0
Longleaf (5-2×self)	"	12	34	14.9	0
Longleaf (5-1)	"	51	80	13.5	0
Longleaf (5-2)	"	39	61	13.4	0
Longleaf (5-1×self)	"	1	50	3.0	0
Shortleaf (6-3)	"	33	92	13.0	0
Species Hybrids					
Shortleaf (6-3) × slash	"	25	69	20.8	3
Shortleaf (6-3) × loblolly	"	33	92	20.6	0
Sonderegger (2-7)	"	18	50	19.5	23
Sonderegger (2-7) × loblolly	"	14	39	19.2	27
Slash (2-4) × loblolly (6-1)	"	47	74	17.2	63
Loblolly (4-1) × Sonderegger (2-7)	"	39	61	17.0	28
	PLANTING C[4]				
Species					
Slash	"	228	84	21.7	17
Longleaf	"	133	78	12.8	0
Species Hybrids					
Slash × shortleaf	"	132	77	24.0	2
Slash × loblolly	"	89	57	23.8	45
Sonderegger × loblolly	"	68	92	22.9	35
Slash × Sonderegger	"	87	61	21.9	31
Longleaf × slash	"	92	58	21.8	3
Longleaf × Sonderegger	"	72	80	20.0	0

[1] On shortleaf and shortleaf hybrids the fungus may be *Cronartium quercuum* rather than *C. fusiforme*.

[2] Hyphenated numbers are tree numbers.

[3] Pollen mix supplied by Institute of Forest Genetics, U. S. Dep. Agr. Forest Service, Placerville, California.

[4] Entries for plantation C are averages for one to four progenies.

Table 3.—*Mean 6-year survival in the D plantings*

Entry	Source	Wet site			Dry site			Difference
		Survival		Rank	Survival		Rank	
		No. of trees	*Percent*		*No. of trees*	*Percent*		*Percent*
Pond × wind	Fla.	15	100	1	7	64	4	36
(Shortleaf × loblolly) × wind	Ark.	10	92	2	12	92	2	0
Loblolly × wind	Local	20	83	3.5	18	72	3	11
Slash × wind	Local	15	83	3.5	18	95	1	−12
(Shortleaf × loblolly) × (pitch × loblolly)	Local × N. J.	15	79	5	7	41	9	38
(Pitch × loblolly) × (shortleaf × loblolly)	N. J. × local	21	72	6	15	60	5	12
Pitch × pond	N. J. × Fla.	8	67	7	6	43	8	24
Pitch × loblolly	? (not local)	12	63	8	6	30	12	33
Shortleaf × shortleaf	N. C. × Ark.	6	60	9.5	4	40	10.5	20
Shortleaf × shortleaf	N. C. × local	9	60	9.5	8	57	6	3
Shortleaf × loblolly	? × local	4	40	11	2	11	15.5	29
Shortleaf × wind	? (not local)	6	37	12	4	25	13	12
(Shortleaf × loblolly) × wind	?	?	30	13.5	?	11	15.5	19
Pitch × wind	N. J.	3	30	13.5	4	40	10.5	−10
Pitch × pitch	N. J.	3	25	15	8	53	7	−28
(Shortleaf × loblolly) × (shortleaf × slash)	? (local)	2	20	16	2	20	14	0

$\bar{x}_d$ = 11.5 percent: t^1 = 2.49*: Spearman rank correlation coefficient = 0.759*

[1] Calculated after arcsin transformation of differences.

The two D plantations had a greater range in site condition—wet to well-drained. Survival was better on the wet, and growth on the dry sites (tables 3 and 4). When the entries were ranked for

Table 4.—*Mean 6-year heights in the D plantings*

Entry	Source	Wet site		Well-drained site		Difference
		Height	Rank	Height	Rank	
		Feet		*Feet*		*Feet*
Slash × wind	Local	15.8	1	14.4	2	1.4
Loblolly × wind [1]	Local	14.7	2	15.4	1	− .7
(Shortleaf × loblolly) × wind	Ark.	13.5	3	13.5	4	0
Pond × wind	Fla.	10.7	4	13.9	3	−3.2
Shortleaf × wind	? (not local)	9.7	5	10.3	9	− .6
(Pitch × loblolly) × (shortleaf × loblolly)	N. J. × local	8.4	6	10.1	10	−1.7
Pitch × pond	N. J. × Fla.	8.0	7	10.5	8	−2.5
Shortleaf × shortleaf	N. C. × local	7.8	8	11.5	6	−3.7
Shortleaf × shortleaf [2]	N. C. × Ark.	7.4	9	13.1	5	−5.7
Pitch × loblolly	? (not local)	6.3	10	7.2	11	− .9
(Shortleaf × loblolly) × (pitch × loblolly)	Local × N. J.	5.8	11	10.6	7	−4.8

$\bar{x}_d$ = 2.04 ft.; t = 3.14*: Spearman rank correlation coefficient = 0.698*

[1] Three trees were infected with *Cronartium fusiforme.*

[2] One tree infected with *Cronartium fusiforme.*

survival by site there was a significant correspondence of rankings between sites. But there were marked rank shifts in survival between sites for three hybrids: (shortleaf × loblolly) × (pitch × loblolly), pitch × loblolly, and shortleaf × loblolly, and one species, pitch pine. Similarly there was a significant association of ranks with respect to height; but some entries, particularly shortleaf and the hybrid (pitch × loblolly) × (shortleaf × loblolly), shifted markedly in rank between sites.

In summarizing the results of the D plantations one can say that increasing soil moisture improved survival but slowed height growth. Shortleaf and pitch pine and their hybrids, however, are exceptions to this statement.

The varied composition and age of the plantings make it difficult to gage the effect of culture and spacing except in the A and B plantations. Both were established at the same time, and the B site was comparable to block III of the A plantation. They differ strongly, however, in cultural treatment, the minimal care and close spacing of the B plantation contrasting with the intensive early care and wide spacing of the A (table 1).

Differences in survival were slight, but early height growth (fig. 1) was much better in the A than in the B plantation. The shortleaf × slash hybrids outgrew slash and shortleaf on these dry sites.

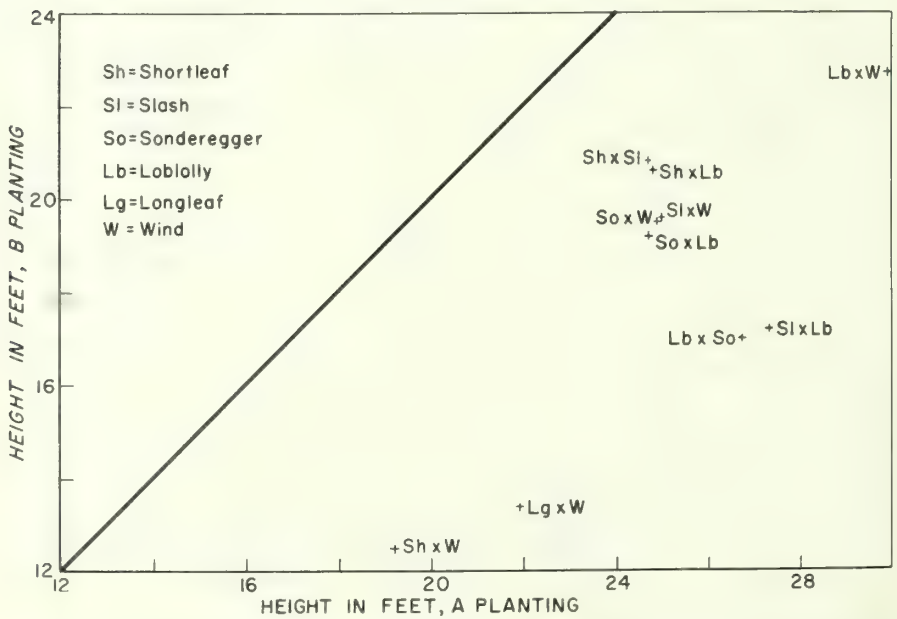

Figure 1.—*Total height in A and B plantings. The hypothetical regression line indicates where the plotted points would fall if there were no difference between plantations.*

Analysis of the last 4 years' height growth in the two plantations resulted in a regression coefficient of 1.05, not significantly different from the hypothetical coefficient of 1.00 for equal growth. Apparently the effects of wide spacing and early intensive care became less important with the increasing age of the A planting.

Effect of Seed and Pollen Parents on Height Growth

In both the A and the C plantings species hybrids and backcrosses were often represented by more than one set of parents. In some cases the progenies of the same species hybrid or backcross differed significantly among themselves.

In the A plantation such differences were apparent in comparisons of height growth of the Sonderegger entries and their checks during the fourth to eighth years in plantation. In table 5 one loblolly backcross to Sonderegger ranks at the top and the other at the bottom; they are significantly different. It is also clear that Sonderegger 2-7 performed well as a pollen parent.

The two slash × loblolly hybrids also differed significantly in total height—26.0 feet vs. 23.7 feet (table 6).

Table 5—*Sonderegger entries and loblolly checks, A planting, and their ranked average terminal height growth*[1] *from fourth to eighth year in plantation*

Entry	Mean 4-year height growth in feet
Loblolly 2-5 × Sonderegger 2-7	14.7
Loblolly 4-1 × wind	14.3
Longleaf 5-2 × Sonderegger 2-7	14.3
Longleaf 1-18 × Sonderegger 2-7	14.0
Loblolly 2-5 × wind	13.7
Loblolly 2-5 × Sonderegger 1-17	13.7
Loblolly 4-1 × Sonderegger 2-7	13.3
Sonderegger 1-17 × wind	13.2
Loblolly 2-6 × Sonderegger 2-7	12.6
Sonderegger 2-7 × loblolly mix	12.5
Longleaf 5-2 × Sonderegger 1-17	12.2
Loblolly 2-6 × wind	12.2
Sonderegger 2-7 × wind	11.8
Loblolly 2-6 × Sonderegger 1-17	11.7

[1] Means which do not differ significantly (0.01 level) are joined by the same common line.

Table 6.—*Slash pine entries and loblolly checks, A planting, and their ranked mean total heights* [1] *at 8 years*

Entry	Mean height in feet
Loblolly 4-1 × wind	29.9
Loblolly 2-5 × wind	29.2
Loblolly 2-6 × wind	28.1
Slash 2-3 × slash 1-4	27.5
Slash 1-4 × slash 2-3	27.0
Slash 1-4 × wind	26.9
Slash 2-4 × wind	26.5
Slash 2-3 × wind	26.4
Slash 2-4 × loblolly 6-1	26.0
Slash 2-3 × loblolly 6-1	23.7

[1] Means which do not differ significantly (0.05 level) are joined by a common line.

The C plantation provided the best illustration of parental effects upon progeny growth and rust susceptibility. On an entry basis longleaf × slash and slash × shortleaf were exceeded only by longleaf and longleaf × Sonderegger (no infection) in their fusiform rust resistance, but among the longleaf × slash families only one out of four became infected whereas three out of four shortleaf × slash families showed some infection.

Progeny heights differed significantly within four entries—all hybrids—of the eight in C (table 7). Families of wind-pollinated slash and longleaf trees differed little in average height. Two hybrid entries, slash × loblolly and longleaf × Sonderegger (a backcross) were also comprised of families with rather uniform heights within an entry.

Table 7.—*Mean progeny heights at 6 years, C planting*

Species	Progeny						Error	
	1	2	3	4	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares
	Feet							
Slash × shortleaf	24.8	24.6	25.3	20.7	3	77.77*	36	12.49
Longleaf × slash	18.5	22.1	22.9	24.4	3	95.26*	31	15.10
Sonderegger × slash	28.5	17.0	[1] 21.9	.	2	241.10*	15	16.10
Sonderegger × loblolly	21.0	24.2	[1] 20.5	.		40.30*		6.47
Longleaf × wind	12.6	12.5	.	.	1	.23	14	8.84
Slash × wind	22.7	21.6	21.1	21.4	3	8.31	40	14.72
Slash × loblolly	25.5	[1] 23.7	20.3	24.8	3	89.42	32	46.47
Longleaf × Sonderegger	18.9	20.2	.	.	1	7.60	8	7.83

[1] Reciprocal cross.

* 0.05 probability level.

Since the crosses within an entry frequently had a common parent, it is worth considering table 7 in detail. The four slash × shortleaf progenies were produced by employing the same shortleaf pollen mix on four slash pines. Consequently progeny differences reflect the influence of the seed parent, and in this instance progeny four was, on the average, 4 feet shorter than the others.

The longleaf × slash hybrids were represented by four progenies also, but pollen mixes were not used. The composition of the crosses and mean heights were:

Cross	Mean height
	(feet)
Longleaf 12-2 × slash 8-4	18.5
Longleaf 12-1 × slash 9-2	22.1
Longleaf 12-2 × slash 10-5	22.9
Longleaf 12-2 × slash 9-2	24-4

Most of the variation in progeny heights is due to the poor performance of the first hybrid listed, longleaf 12-2 × slash 8-4. Since two other progenies of longleaf 12-2 grew satisfactorily, this tree did not combine well with slash 8-4.

The most striking differences in mean height of progeny are those of the Sonderegger × slash entry—a hybrid outcross to slash pine. The genome is half slash with varying proportions of loblolly and longleaf. Composition and mean heights of the crosses are:

Cross	Mean height
	(feet)
Sonderegger 18-61 × slash 9-2	17.0
Slash 8-2 × Sonderegger mix	21.9
Sonderegger 2-7 × slash 9-2	28.5

Slash 9-2 as a common pollen parent on two Sondereggers produced progenies that differed in 6-year height by more than 10 feet. The reciprocal hybrid cross was intermediate.

Assessment of Hybrid Performance

Field survival of F_1 interspecific hybrids was somewhat less than that of backcrosses and species entries, but this was chiefly due to the poor survival of slash × loblolly in all plantings that included it. Though survivals of longleaf × slash hybrids differed markedly between plantings (86 percent in A, 57 percent in C), field survivals of hybrids on both intensively cultivated and "rough" sites have been only slightly less satisfactory than survival of native species on the same sites.

In susceptibility to fusiform rust the hybrids display extreme contrasts. The slash × loblolly hybrids were consistently more susceptible than any other hybrid, or than the susceptible check species, loblolly and slash (fig. 2). On the other hand the longleaf × slash, shortleaf × slash (and reciprocal), and shortleaf × loblolly hybrids were remarkably free of rust (fig. 2). It must be remembered, how-

ever, that in field tests amounts of natural inoculum are likely to vary from year to year. Critical tests are being made of seedlings in inoculation chambers *(10)*. These tests should assist also in evaluating a "dosage" effect noted in the field, where slash × loblolly (susceptible × susceptible) was an extremely susceptible hybrid, Sonderegger × loblolly (intermediate × susceptible) was a susceptible hybrid; and Sonderegger × longleaf (intermediate × resistant) was a very resistant hybrid. These relationships suggest that, among species, polygenes (in perhaps different loci) determine susceptibility to rust, although within a species the control may be more rigid. Further studies with species as well as hybrids should provide information concerning gene-controlled rust susceptibility.

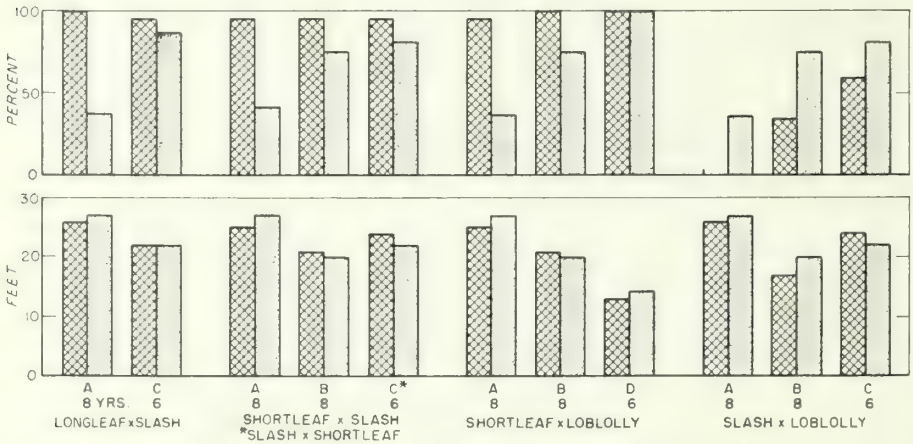

Figure 2.—*Performance of interspecific southern pine hybrids (hatched bars) with respect to slash pine (stippled bars). Letters indicate plantings.* Top: *percent of seedlings free of fusiform rust.* Bottom: *total height; numerals indicate years in field.*

With respect to hybrid persistence, then, field survival was adequate but rust resistance varied with species composition. Loblolly × slash hybrids cannot be recommended for any area where fusiform rust is a hazard, and because of the devastating effect of the rust in these tests no assessment of growth can be made for rust-free areas. Shortleaf × loblolly, shortleaf × slash, and longleaf × slash were relatively rust-resistant in comparison to check species. Figure 2 makes clear, moreover, that these hybrids grew almost as well on the average as local slash pine; indeed, on the drier sites the shortleaf × slash hybrids enjoyed a slight advantage.

The D plantations include the pitch × loblolly hybrid, which has performed very well in Korea *(9)*. At Gulfport this cross has grown too slowly to be of any value (table 4). Pond pine, which

is also in this test, grew well and provided the best pitch pine hybrid; two surviving pond × loblolly trees (this hybrid is omitted from table 4 because of poor survival) attained a height of 17 feet, almost 2 feet more than local loblolly. Species hybrids involving pond pine, especially pond × loblolly, warrant further testing.

Discussion

The south Mississippi plantings show that southern pine interspecific hybrids tend to be intermediate in growth to the parent species. It would seem that, where both parents are adapted and have good growth characteristics, hybrid intermediacy would be of little practical consequence. Where one of the parents is shortleaf —a species near its southern range limit in south Mississippi—the influence of the better adapted parent is readily seen.

An important feature of interspecific hybridization, however, is the combination of useful specific characters. For example, fusiform rust resistance from the shortleaf parent has been reported to be passed to a significant degree to hybrid progeny *(7, 8)*: these early results are amply confirmed by the data reported here from older plantings and different parents. Similarly longleaf × slash hybrids have been shown to be resistant to rust in Louisiana *(3)*. They also have little or no grass stage in their juvenile development *(6)*, and perhaps as a consequence are very resistant to brown-spot needle blight *(3)*, a serious disease of longleaf.

This one-step incorporation of desirable specific characters in hybrid progenies is an important justification for pursuing an interspecific pine hybridization program within the natural limits of crossability. If two species are crossable, however, then it must be supposed that they have a number of loci in common. The particular patterning of alleles, loci, and their interactions becomes of paramount importance in character expression, and ultimately in performance. Consequently parent selection can be expected to improve hybrid performance. Family comparisons in these plantations indicate that this supposition is well founded even though the parental material was chosen essentially at random.

In the light of these results, what can be said of interspecific hybridization as the basis of a southern pine tree improvement program? For loblolly and slash undirected interspecific hybridization with shortleaf or longleaf would improve resistance to fusiform rust. There is also some indication that a shortleaf × slash hybrid would grow well on the drier sites in south Mississippi, but figure 2 indicates that breeding for heterosis is not practical.

Alternatively, the inclusion of selected trees from two species in a seed orchard would have the dual advantage of incorporating spe-

cific characters from one species, e. g., rust resistance, and improved growth from both species and crosses between them.

Another possibility is to employ undirected interspecific hybridization as a means of creating exceptional individuals that could be incorporated into seed orchards. Although the results from the Harrison plantations have been presented here as progeny means, hybrid individuals ranged from dwarfs to relative giants; transgressive segregation has been a feature of interspecific hybridization in the southern pines.

In summary, undirected hybridization does not appear to be a practical improvement technique in the southern pines, but there is little question concerning its effectiveness in incorporating certain species characteristics into a hybrid that could in turn be utilized in tree-breeding programs.

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E. R. Ferguson
E. R. Lawson
W. R. Maple
C. Mesavage

Southern Forest Experiment Station
T. C. Nelson, Director

Forest Service
U. S. Department of Agriculture

MANAGING EASTERN REDCEDAR

E. R. Ferguson, E. R. Lawson, W. R. Maple, and C. Mesavage

Eastern redcedar *(Juniperus virginiana* L.) is the most widely distributed conifer of tree size in the Eastern United States *(48)*. Its range also extends into southeastern Canada. The wood was once favored for domestic use and export because of its exceptional cutting qualities, durability, rich color, and aroma. It has now lost much of its popularity because of limited supply. The magnificent stands of redcedar so often mentioned by early explorers have been cut, and for a number of years redcedar has been primarily confined to fence rows, abandoned fields, and submarginal lands where it often grows poorly.

The species ranks among the top five for Christmas trees *(40)*, and is an important constituent of shelterbelt plantings in the Great Plains *(48)*. The fruits are eaten by many wildlife species, including birds, rabbits, foxes, raccoons, skunks, and coyotes. The foliage is eaten by deer when other food is scarce *(13)*.

Most redcedar is cut from small farms, where its management should be encouraged. It generally occupies sites which are too rough or rocky for agricultural crops, and salable products are small enough to be handled with ordinary farm equipment. This paper presents information on growing and managing redcedar. It is a compendium of published knowledge on the species, supplemented by current research results from northern Arkansas.

Tree Characteristics

Eastern redcedar grows slowly, and long rotations are required to produce conventional saw logs. Trees 20 to 30 years old are generally 18 to 26 feet tall and 2¼ to 3 inches in diameter *(9)*. Mature trees are small to medium sized, usually 40 to 50 feet tall with a short bole 12 to 24 inches in diameter. On good sites they may reach 120 feet tall and 4 feet in diameter *(7)*. On dry sites in the prairie region, trees 110 years old are often less than 20 feet tall *(48)*.

Tiny evergreen leaves are borne in two forms. Those on seedlings and vigorous twigs are sharp pointed and awl shaped. On less vigorous stems, closely overlapping scale-like leaves fit tightly against the twig in opposite pairs (fig. 1). Scale-like leaves are usually about 1/16-inch long and dark blue-green; they turn russet or yellow-brown during the winter. From February to May small inconspicuous male and female flowers appear—almost always on separate trees.

The fruit is a berry-like cone which is fleshy, dark blue, and highly aromatic. Cones mature in one season. They contain two (rarely three or four) small seeds, which number 17,600 to 59,000 to the pound *(46)*.

Distribution

The species occurs in every State east of the 100th meridian (fig. 2). It also appears in southern Ontario, the southern tip of Quebec *(48)*, and in some parts of New Brunswick and Nova Scotia *(47)*. Throughout its range the species grows under diverse conditions—in deep and shallow soils, on ridgetops, and in bottoms.

Eastern redcedar sawtimber volume in the United States was estimated to be 490 million board feet in 1953 *(47)*. The largest remaining stands are in the mountains of Arkansas, Missouri, Tennessee, and Kentucky. Substantial amounts are also found in the Carolinas and Virginia.

Figure 1.—
Awl-shaped leaves on vigorous twig (left); fruit and scale-like leaves on mature twig (right).

Figure 2.—*Range of eastern redcedar.*

In Arkansas, redcedar is the dominant commercial species on about 600,000 acres, according to the most recent forest survey report *(41)*. Most of this acreage is in the Ozarks. The area supports 28 million cubic feet of growing stock and 43 million board feet of sawtimber. Another half million poorly stocked acres might be better suited for redcedar than the species now present. Adjacent areas in Missouri have roughly 500,000 acres stocked with or suitable for redcedar *(23)*. The latest survey in Missouri *(16)* showed a growing-stock volume of 17 million cubic feet and a sawtimber volume of 6.6 million board feet.

Redcedar is the dominant species on 600,000 acres in Tennessee *(42)*, with 66 million cubic feet of growing stock and 105 million board feet of sawtimber. Kentucky contains over 500,000 acres of redcedar type, approximately 53 million cubic feet of growing stock, and 91 million board feet of sawtimber *(14, 17, 18)*.

In the Southeastern United States most redcedar volume is scattered in types other than cedar. Virginia has 120,000 acres of cedar type, 50 million cubic feet of redcedar growing stock, and 65 million board feet of sawtimber *(25)*. The type covers 77,000 acres in the Piedmont region of South Carolina, which contains growing stock and sawtimber volumes of 37 million cubic feet and 40 million board feet *(21, 27)*. Approximately 28,000 acres of cedar type are found in North Carolina. The State contains 36 million cubic feet of growing stock and 57 million board feet of sawtimber *(24)*. Relatively small amounts of commercial redcedar occur in other sections of the species' range.

Site Requirements

The species is so frequently associated with limestone ledges that it is commonly believed to grow only on dry, rocky soils. Like most tree species however, redcedar grows best on deep, moist, well-drained alluvial sites, where its height may reach 55 to 60 feet at 50 years of age. It rarely becomes dominant on such sites because of competition from other species.

It also grows well on deep, upland soils, particularly abandoned farmland. A 1-acre plantation established in the Arkansas Ozarks with transplanted wildlings on a 6 by 6 foot spacing yielded a basal area of 163 square feet and an estimated 2,800 cubic feet of merchantable volume in 44 years *(4)* (fig. 3).

Figure 3.—
A 44-year-old redcedar plantation in northern Arkansas.

The species is now generally confined to glades—areas of thin rocky soil with intermittent rock outcrops. Estimating soil depth is difficult, because soil-filled fissures must be included. Very poor sites contain few fissures in the parent material; their soils are generally less than 12 inches deep. Such sites produce short-bodied trees whose merchantable length rarely exceeds one 6½-foot post.

Medium and good glade sites have large crevices. Soil depth on medium sites is usually less than 2 feet; good sites have deeper soil. Figure 4 shows a stand on a good site. Unfortunately, hardwoods usually quickly crowd out the cedar on such areas.

Redcedar grows surprisingly well in soils with high rock content. The authors exposed a portion of the roots of a desirable crop tree and found that limestone rocks comprised over 52 percent of the total soil volume (fig. 5). Root development was greatly influenced by the size of the soil-filled fissures.

The species establishes itself on adverse hardwood sites, and hastens soil changes *(5, 11)*. High soil acidity does not seem to deter its establishment. Arend and Collins *(7)* inferred that neutral to alkaline soils are a result rather than a cause of redcedar's presence on certain sites. The high calcium content of its foliage (over 2 percent) tends to change soils from acid to alkaline in a comparatively short time, perhaps less than 15 years *(11, 12)*. Read and Walker *(39)* reported that redcedar

Figure 4.—*Natural stand of eastern redcedar on the Koen Experimental Forest in Arkansas.*

Figure 5.—*Rocks occupied 53 percent of the volume around the roots of this tree. The soil was removed and rocks were replaced in approximately their original positions.*

litter, through its influence on calcium content and pH of the surface soil, improves the environment for earthworms. Earthworm activity increases organic-matter content through litter incorporation, lowers volume weight, and increases pore volume, air capacity, and infiltration rate. Broadfoot *(12)* found striking differences between the soil under eastern redcedar trees and that under other herbaceous cover. He found that the A_1 horizon was thicker under cedar and had twice the organic matter and available calcium. He attributed superior qualities of the soil under redcedar to the influence of litter, and recommended the species for soil rehabilitation.

The growth and character of 91 natural stands of eastern redcedar were studied throughout the Ozarks by Arend and Collins *(7)*. For each stand the soil type, soil depth, topographic position, and direction and degree of slope were classified. Composite soil samples for pH determinations were taken at depths of 0 to 3 and 3 to 6 inches. In each stand, 30 to 40 individual trees were selected for measurement of total height, merchantable height, age, diameter at breast height, diameter growth during the past 10 years, bark thickness, stem taper, and length and width of crown.

Depth of soil was the principal site factor affecting growth and character on upland soils. Soil acidity within the pH range of 4.7 to 7.8 had little effect on growth. Four site classes for eastern redcedar in the Ozarks were recommended (table 1).

Table 1.—*Site classes for natural redcedar stands in northern Arkansas*

Site class	Soil character	Soil depth	Site index [1]	
			Open stand	Closed stand
		Inches	*--Feet--*	
I	Alluvial	24 +	55	60
II	Upland	24 +	45	50
III	Upland	12-23	35	40
IV	Upland	Less than 12	25	30

[1] Adjusted to age 50 *(7)*.

Aspect influences the character of stands but not their total growth and yield *(7)*. On north and east slopes there were generally fewer redcedar trees because of hardwood competition, but those that did occur were slightly taller than trees on south and west slopes. Topographic position was related to depth of soil, with lower slopes tending to produce taller trees because of greater soil depth.

Arend and Collins *(7)* report that: "As the trees grow older, the quality of the site has a more significant effect on height growth. Although stand density normally has little effect on height growth of most forest species, open grown redcedar trees in the region do not grow as tall as when found in dense stands."

Natural Regeneration

Good seed crops occur every 2 or 3 years, with light crops in the intervening years. Seed dispersion depends heavily upon birds and small mammals *(5, 34, 36, 46)*. The best seed-bearing age is between 25 and 75 years, although some trees will bear at 10 years, and some after passing the century mark.

Seeds usually germinate in early spring of the second year after dispersal; a few germinate the first and third years. Delayed germination is caused by embryo dormancy and possibly by an impermeable seedcoat *(46)*. Passage through an animal's digestive tract speeds seed germination *(36)*.

Intensive site preparation is usually not needed, but seedling establishment is improved by removing litter. The seedlings are intolerant, and survival is better under open than closed canopies *(37)*.

Established seedlings withstand drought well, perhaps because of their deep, penetrating taproot and relatively small leaf surface. During the first year, seedlings do not develop large tops, but they produce a long fibrous root system. On very dry sites most seedlings are found in protected places, such as cracks in limestone, where the microclimate is most favorable for germination *(3)*.

Eastern redcedar is among the first tree species to invade old fields *(5)*. Beilmann and Brenner *(8)* attribute its vigorous encroachment to the control of indiscriminate burning. On deep soils, associate invasion species, such as persimmon *(Diospyros virginiana* L.) and sassafras *(Sassafras albidum* (Nutt.) Nees) may soon crowd out the redcedar. Although it occurs occasionally in almost pure stands on glades, redcedar is frequently associated with winged elm *(Ulmus alata* Michx.) and blackjack oak *(Quercus marilandica* Muenchh.) *(39)*. Post oak *(Q. stellata* Wangenh.), white ash *(Fraxinus americana* L.), and xerophytic shrubs are also found with redcedar in Missouri *(26)*. Such consociations may eventually be replaced by climax hardwood species, including sugar maple *(Acer saccharum* Marsh.) and white oak *(Q. alba* L.) *(43)*.

Planting and Seeding

For such a well-known species, there is little information on the planting of redcedar. Gruschow *(20)* reported a test of seven methods of planting in the Virginia Piedmont; survival ranged from 27 to 41 percent after 4 years. He concluded that factors other than planting methods were influencing survival. Maple *(28)* found survivals of planted 1-0 redcedar ranging from 0 to 44 percent in the Arkansas Ozarks, but attributed poor success to low vigor of the planting stock.

In contrast, Moore *(35)* achieved 99 percent survival in Alabama, and Meade *(29)* describes a 9-year-old plantation in Arkansas with 90 percent survival. Arend *(4)* reports 84 percent survival in a 44-year-old plantation in Arkansas established from hand-pulled wildlings.

It is obvious that redcedar plantations can be successful. The failures reported indicate that site and competition need to be carefully considered. Afanasiev *(2)* summed the problem up when he said, "Both seed and seedling are very exacting in site requirements and need constant care."

Experience in northern Arkansas indicates that mowing or spraying with chemicals to control competing vegetation may maintain satisfactory survival.

There is little literature on techniques for direct-seeding eastern redcedar. Afanasiev *(1)* reported two abortive attempts in Oklahoma. In both cases, the seeds were stratified in late fall and were considered to be completely after-ripened when they were sowed.

Pilot studies of machine and hand direct-seeding on the Piedmont were conducted by Minckler and Downs *(33)*. Both hand and furrow seeding were successful. Stratified seeds were sown at the rate of 1.2 pounds per acre (18,000 seeds per pound). The machine method resulted in 2,500 seedlings per acre with a stocking percent of 86 on 8.5- by 8.5-foot quadrats.

Seedling catch and survival are improved by removing litter and either thinning or removing the overstory *(37)*.

To insure maximum germination in minimum time, seeds must be cleaned, treated to increase seedcoat permeability, and stratified in a moist medium for up to 4 months at 35 to 41° F. *(44, 46)*. If immediate stratification or sowing is not planned, the cleaned seed should be dried to a moisture content of 7 percent and stored at 20° F. *(46)*.

Protection

The thin bark of eastern redcedar offers little protection against fire. Fortunately, the foliage does not burn readily, and litter accumulation is limited under stands on thin soils. Thus, the lack of fuel protects many stands in areas where fire occurrence rate is high.

On deep soils, competing species produce enough litter to support fire. Sufficient flash fuels to carry fire are usually available on grasslands and old fields, which are aggressively invaded by redcedar. Beilmann and Brenner *(8)* point out that the beginning of successful invasion by redcedar on these areas coincides with the reduced burning of grasslands. Single fires usually kill trees (fig. 6). Such fire-killed stands must be regenerated artificially, for redcedar does not sprout.

Herbs and native grasses are relatively abundant on cedar glades, which are grazed extensively. Like wildfire, cattle grazing damages the shallow soil by increasing compaction, surface runoff, and erosion. Redcedar roots are injured by sharp hooves, and seedling and sapling height growth is practically erased by browsing *(38)*.

Most authorities agree that redcedar foliage, although not a preferred deer food, carries deer populations through periods when more desirable plants are in short supply. During such times, browse lines develop on old trees and younger ones become hedged. Most reproduction is destroyed *(13)*.

Insects usually do not seriously damage eastern redcedar. Boring insects sometimes feed on living and dead trees, and bagworms *(Thyridopteryx ephemeraeformis* (Haw.)) occasionally completely defoliate a tree. Redcedar aphids *(Cinara sabinae* Gill.) may cluster on twigs and smaller branches, occasionally kill-

Figure 6.—*Single fires usually kill redcedar because the thin bark offers little protection from the heat.*

ing the infested portions, and sometimes the whole stem *(15)*.

The trees are especially susceptible to a disease commonly known as cedar-apple rust *(Gymnosporangium juniperi-virginianae* Schw.). Fungi of this genus are also responsible for witches'-broom and spindle-shaped swelling of trunks and branches of large trees *(10)*. Apple, pear, quince, mountain-ash, hawthorn, and serviceberry are some of the common alternate hosts. Though rarely fatal to redcedar, these diseases are damaging to apples. In some States, complete eradication of all cedars and junipers within a mile of an apple orchard is required by law *(10)*.

Cubical rot fungi *(Fomes subroseus* (Weir) Overh. and *Daedalea juniperina* Murr.) and juniper pocket rot fungus *(F. juniperinus* (V. Schr.) Sacc. & Syd.) enter through dead branch stubs and attack the heartwood of eastern redcedar *(10, 45)* (fig. 7). Hence, pruning is usually not recommended. Tight knots are not classed as defects. Where it is necessary, pruning should leave 8- to 10-inch branch stubs to minimize fungal attack *(22)*.

Figure 7.—Daedalea juniperina *causes heart rot in redcedar.*

A root rot *(Fomes annosus* (Fr.) Karst.) sometimes extends into the sapwood above the rootcollar of suppressed trees. The pathogen can kill weakened trees *(10)*. Miller *(32)* suggested reducing or eliminating competition for light to reduce losses to this disease.

Competition Control

Eastern redcedar is an aggressive pioneer species that invades old fields and pastures *(6)*. It is classed as very intolerant in New York and New England, and intolerant in the Southeastern United States *(48)*.

On deep soils, it is usually crowded out by vigorous hardwoods and pine after a single rotation. On shallow soils, redcedar competes more successfully, because hardwood growth is sparser and less vigorous.

Meade *(30)* attempted to convert low-grade hardwood stands to redcedar by planting beneath hardwood overstories ranging from 0 to 56 square feet per acre (stems 0.5 inch d.b.h. and larger). Redcedar was unable to compete with the residual hardwoods and sprouts. Meade *(30)* concluded that it is not suitable for underplanting where the overstory is removed by cutting or girdling, since prolific sprouting results. With more effective methods of hardwood control, such as injecting or spraying with 2,4,5-T, the results might have been different.

Eastern redcedar is relatively insensitive to foliar application of 2,4,5-T and 2,4-D at the concentrations normally used to control undesirable broadleaf vegetation. This "immunity" has resulted in the accidental conversion of quite a few acres of hardwood brush to almost pure cedar in the Arkansas-Oklahoma-Missouri junction area (fig. 8). Ranchers desiring to eliminate woody species and convert to grass indiscriminately spray with 2,4,5-T. Most hardwoods are killed back, and the redcedar thrives with release and becomes dominant.

Aerial spraying can help to perpetuate the redcedar type. On glade soils it should succeed with modest outlays. On better soils, several successive applications may be required to provide maximum release for cedar growth, and periodic treatment may be needed during the rotation.

Whether chemicals or a combination of machines and chemicals are used, it is essential to control competing vegetation in redcedar management. Complete hardwood removal is recommended.

Figure 8.—
Redcedar invades grasslands sprayed with herbicide to control broadleaf vegetation.

Growth and Yield

Growth studies in northern Arkansas indicate that even-aged management is suitable for eastern redcedar. Although growth is relatively slow on glade sites, small sizes of products and large latitude in acceptable defects make short rotations possible. A cutting cycle of 6 to 10 years is suggested. Observations indicate that 20 to 30 years will be required for posts, and 40 to 60 years for sawtimber. Greatest yields will probably accrue from sawtimber rotations with intermediate cuttings for posts, although post rotations appeal to many farmers.

Arend and Collins *(7)* provided some of the earliest data on diameter growth by site class in natural redcedar stands (table 2). The classes mentioned below are those described in table 1. Sophisticated analyses of Arend and Collins' *(7)* data yield the equations:

Site class	Total height	R^2
II	$\sqrt{39.46\,(\text{age}) - 178.6}$	0.908 [1]
III	$\sqrt{27.75\,(\text{age}) - 133.4}$	.733 [1]

Table 3 shows the height-age relationships computed from the equations.

[1] Statistically significant at the 0.01 level.

Table 2.—*Average annual diameter growth of dominant trees, by site class and stand density* [1]

Site class	Understocked	Well stocked	Overstocked
	Inches		
I	0.30	..	...
II	.32	0.32	0.15
III	.18	.17	.10
IV	.14	.12	.07

[1] Based on increment core measurements of 456 trees *(7)*.

Table 3.—*Total tree height, by age and site*

Ring-count [1]	Total height	
	Site II	Site III
	Feet	
10	15	12
15	18	17
20	25	20
25	28	24
30	32	26
35	35	29
40	37	31
45	40	33
50	42	35

[1] False rings make accurate age determination difficult. Age is therefore computed from the total number of growth rings.

Height of dominant and codominant trees on the sample plots was related to d.b.h. by Meyer's method *(31)*. The relationship between age and d.b.h. is tempered by stocking. Data were pooled for age and site classes, and equations were compiled:

Stocking	Total height	R^2
Closed	$4.5 + 76.5[1-e^{-0.084\ d.b.h.}]$	0.986
Dense	$4.5 + 57.7[1-e^{-0.09\ d.b.h.}]$	.985
Open	$4.5 + 50.0[1-e^{-0.08\ d.b.h.}]$	.839

where e is the base for natural logarithms.

Height growth, a reflection of soil depth and fertility, increases with stocking density (fig. 9).

Several other studies on growth and yield of eastern redcedar have been conducted in northern Arkansas. In one, improvement cuttings and partial release from hardwoods left an understocked 40-year-old stand. After 6 years, residual stocking rose from 13.5 square feet to over 24 square feet of basal area per acre. Volume growth was 160 cubic feet, inside bark, per acre on an initial stocking of about 190 cubic feet. During the study period, the areas supported an additional 6 square feet of scattered desirable hardwood basal area.

In another study, plots were established in 45-year-old redcedar stands on glades derived from alternating beds of dolomite and sandstone. These even-aged stands averaged about 5 inches d.b.h. and were considered to be well stocked for an intermediate site. The stands occupied all aspects of the upper slopes in a small drainage area. Soil depth varied from 12 to 30 inches on benches between rock ledges. Before cutting, stocking of redcedar 0.6 inch and larger ranged from 33 to 48 square feet of basal area per acre. Treatments compared heavy and light cuts with no cutting. Competing hardwoods were cut on half the plots.

Response to hardwood control was pronounced (fig. 10). The residual redcedar overstory suppressed hardwood sprout competition, even though herbicides were not used. Highest redcedar volume growth was obtained on the unthinned areas from which hardwoods had been removed. These plots yielded 28 cubic feet per acre per year during the 14-year period—double the increment where hardwoods were left. Growth on partially cut areas was 24 cubic feet on released and 13 cubic feet on unreleased plots. Heavily cut areas grew least—14 and 9 cubic feet per acre per year on released and unreleased plots.

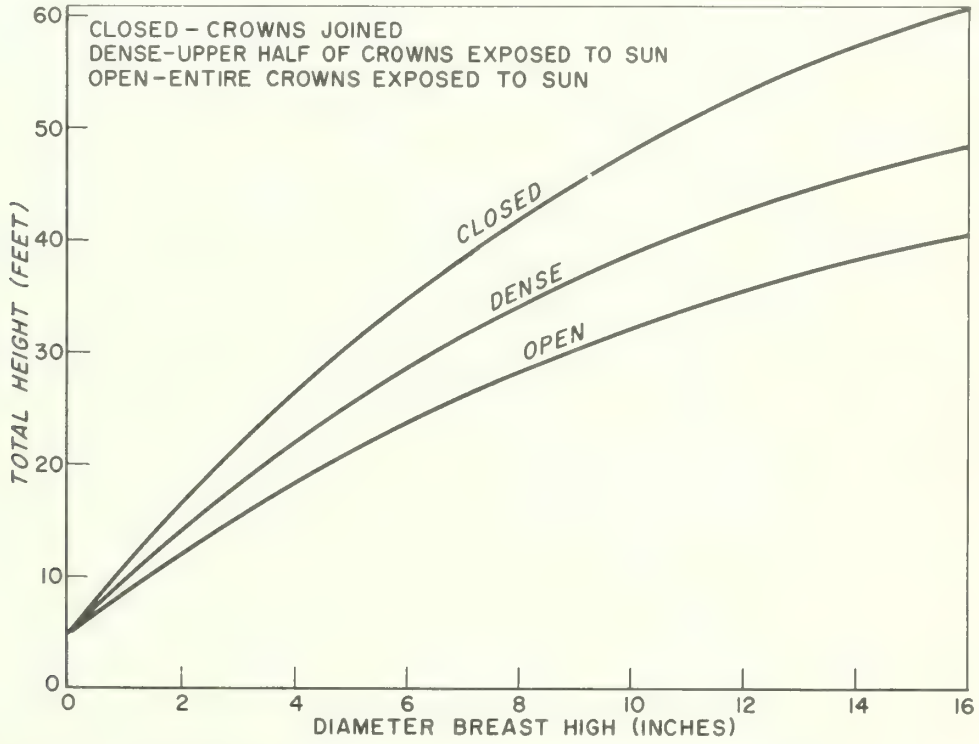

Figure 9.—*Relation of height to d.b.h., by stocking class.*

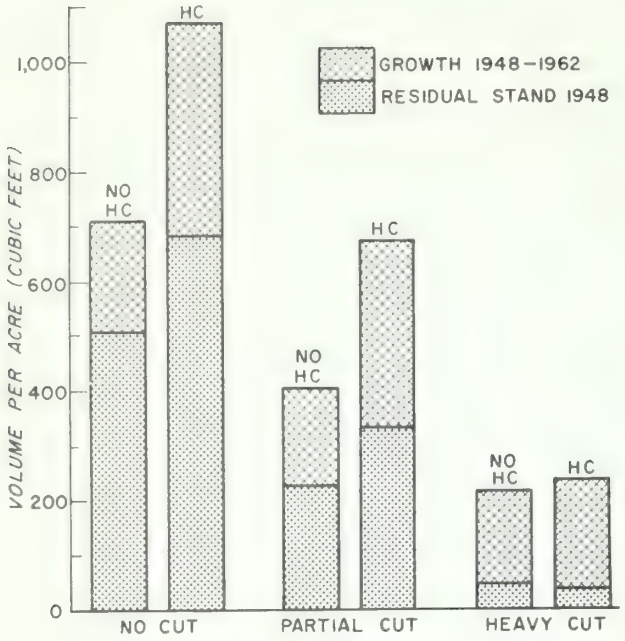

Figure 10.—*Hardwood control (HC) and residual volume influence growth.*

The value of release in well-stocked stands of eastern redcedar and associated hardwoods is demonstrated in figure 11. A stocking of 175 crop trees, 3.0 inches d.b.h. and larger, with 80 percent of the competing vegetation removed had about the same 14-year total growth as 440 trees which had not been released.

Over a 10-year period in northern Arkansas, completely released plots averaged higher d.b.h., basal area, and volume growth than plots where only crown competition was removed. Table 4 shows that the greatest mean diameter increase occurred with the lightest stocking, 50 crop trees per acre; as stocking increased, mean d.b.h. growth decreased. The greatest basal area increase was on plots stocked with 400 crop trees per acre, and as stocking decreased basal area and volume growth decreased.

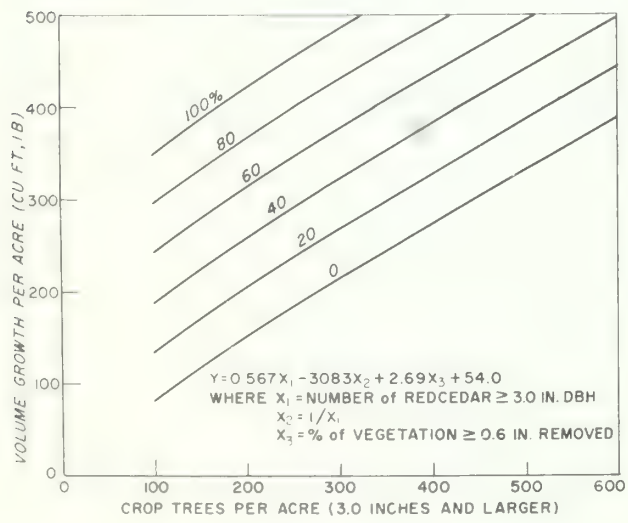

Figure 11.—*Relation of volume growth to stocking and percent of release.*

Table 4.—*Growth of eastern redcedar crop trees after release, 1955-1964*

Stocking (crop trees per acre)	Release	D.b.h.	Basal area	Volume [1]
		Inches	*Sq. ft. per acre*	*Bd. ft. per acre*
400	Complete [2]	1.8	32.7	2,180
	Partial [3]	1.3	24.9	1,570
175	Complete	2.2	21.1	2,340
	Partial	1.8	16.1	1,760
50	Complete	2.5	7.9	940
	Partial	2.4	7.1	720

[1] International ¼-inch rule, revised.
[2] Removal of all woody competition.
[3] Removal of trees overtopping or competing with crop-tree crowns.

An initial stocking of 400 eastern redcedar crop trees per acre, averaging about 3 inches d.b.h., produced over 2,000 board feet per acre (International ¼-inch rule, revised) in 10 years. A stocking of 175 4-inch redcedars produced slightly more board-foot volume on similar sites in the same period.

Post production is maximized by maintaining relatively dense stands. Sawtimber production can be hastened, possibly at some expense in total yield, by thinning one or more times before the harvest cut. The ideal density for growing saw logs is not known, but drastic thinning must be avoided to prevent excessive formation of sapwood.

Marketing the Crop

For a variety of reasons, many farmers harvest redcedar themselves. Their equipment is usually large enough to handle typical logs, and posts are often needed on the farm. Wages from logging are good, and the redcedar volume on most farm woodlots is not large enough to attract a logging contractor. In harvesting,

it is usually most profitable to cut as many logs as possible, then convert the remaining material into posts.

Saw logs are generally bucked into lengths of 8 feet 3 inches, including a trim allowance of 3 inches. Grade specifications permit sound knots, white streaks, and tight, firm pitch, but wood must be sound. Lumber grades are based on the proportion of a board that will yield sound cuttings, with certain limits of length, width, and proportion of sapwood. Variations in thickness are permitted, and odd lengths are admitted without limit.

Redcedar grades allow shorter and narrower boards than are provided by standard log rules, and special rules have been developed to furnish estimates of log scale. A rule that comes close to mill tally is the revised International ¼-inch rule prepared by Grosenbaugh and Arend *(19)* and compiled in table 5.

The merchantable portion of cedar trees is not affected by number of limbs, and thus, trees can be worked into products to a fixed minimum top diameter—5.6 inches for saw logs and 2.6 inches for posts. Tree taper is influenced primarily by stand density; it is greatest in open-grown trees. Estimates of log taper are shown in table 6, which was compiled from dense redcedar stands on the Koen Experimental Forest in Newton County, Arkansas.

Standard length of a post is 6 feet 8 inches, including a 2-inch trim allowance. Value is governed by the diameter at the small end, if round, and by perimeter at the small end, if split. Split posts have a greater value than round posts of the same perimeter, because they have more decay-resistant heartwood exposed. Post values are not proportional to cubic- or board-foot contents, and hence, estimates must be made in terms of pieces. Round

Table 5.—*Volume of 8-foot logs to nearest board foot, by scaling diameter (i. b.), revised International ¼-inch rule* [1]

Diameter (inches)	Diameter (tenths of inches)									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	Board feet									
5	8	8	9	9	9	10	10	11	11	11
6	12	12	13	13	14	14	15	15	15	16
7	16	17	18	18	19	19	20	20	21	21
8	22	23	23	24	24	25	26	26	27	28
9	28	29	30	30	31	32	32	33	34	35
10	35	36	37	38	38	39	40	41	42	42
11	43	44	45	46	47	47	48	49	50	51
12	52	53	53	54	56	57	57	58	59	60
13	61	62	63	64	65	66	67	68	69	70
14	72	73	74	75	76	77	78	79	80	82

[1] $0.40D^2 - 0.52D + 0.53$ for 8-foot section from Grosenbaugh and Arend *(19)*.

Table 6.—*Average diameter (i.b.), at the small end, of 8-foot saw logs cut from trees on the Koen Experimental Forest, Newton County, Arkansas*

D. b. h., o. b. (inches)	1-log trees	2-log trees		3-log trees		
		1st log	2nd log	1st log	2nd log	3rd log
	Inches					
7	6.0	6.2	5.6	..	.	..
8	6.5	6.8	5.7	6.8	6.4	6.0
9	7.1	7.6	6.0	7.6	6.9	6.1
10	7.8	8.4	6.2	8.4	7.4	6.2
11	8.5	9.2	6.5	9.2	8.0	6.4
12	9.1	10.0	6.8	10.0	8.5	6.5
13	9.9	10.8	7.1	10.8	9.0	6.6
14	10.6	11.5	7.3	11.5	9.5	6.7

posts larger than 5 inches at the small end are generally split to increase yield and value. Table 7 indicates the typical yield of split posts from round bolts. Table 8 shows the average post output of trees, by d.b.h. and merchantable height, on the Koen Experimental Forest.

Table 7.—*Number of split posts and perimeter of posts to be expected from redcedar bolts, by top diameter*

Top d. i. b. (inches)	Split posts	Perimeter
	Number	*Inches*
6	2	9-12
7	2	9-12
8	4	14
9	4	15.5
9	6	12
10	4	17
10	6	13
11	4	14
12	6	12
13	6	17.5
13	8	14
14	8	16
15	8	17

Table 8.—*Average number of split and round redcedar posts obtainable per tree, by d.b.h. and merchantable height, Koen Experimental Forest*

D. b. h. (inches)	Merchantable height [1]			
	6'8"	13'4"	20'0"	26'8"
	Number			
4	1	2		
5	1	2	3	
6	1	2	3	4
7	2	3	4	5
8	3	4	5	7
9	3	4	5	7
10	4	5	6	8
11	4	5	6	8
12	6	7	8	10

[1] To minimum top d. i. b. of 2.6 inches.

In northern Arkansas, the prevailing price for redcedar saw logs delivered to a mill is about $80 per thousand board feet. For small volumes, most mills pay per piece, rather than per board foot. Representative prices for logs 8 feet 3 inches long in 1968 were:

Top diameter (inches)	Price
6	$0.80
8	1.45
10	1.90
12	2.60
14	3.60

Many communities do not have buyers for both saw logs and posts, but it is usually possible to find several prospective buyers for delivered wood in surrounding communities. Particularly when a large volume is being sold, comparing the offers of all possible purchases is worthwhile.

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Selected Bibliography on Southern Range Management, 1962-1967

V. L. Duvall
A. W. Johnson
L. L. Yarlett

Southern Forest Experiment Station
T. C. Nelson, Director
Forest Service
U. S. Department of Agriculture

in cooperation with

Southern Section
American Society of Range Management

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Selected Bibliography on Southern Range Management, 1962-1967

V. L. Duvall, A. W. Johnson, and L. L. Yarlett [1]

A *Selected Bibliography on Southern Range Management*[2] was published in 1963. It listed important publications relating to rangelands of the South, the domestic livestock and wildlife produced thereon, and the management of these lands, livestock, and wildlife. The listings extended through 1961 and included certain publications through August 1962.

The present bibliography lists publications that appeared from 1962 through 1967, exclusive of those in the 1963 compilation.

In evaluating publications for inclusion, the compilers considered that the southern range area extends from Virginia westward to eastern Oklahoma and southward to Florida and eastern Texas, and also takes in the southern portions of Kentucky and Missouri. The publications selected were those judged most useful to range interests of this region: land managers and administrators, stockmen, conservationists, scientists, teachers, and students. Since pasture forage commonly augments the diets of animals produced mainly on southern ranges, pertinent publications on supplemental pastures are included.

Classification is by the system used in *A Selected Bibliography on Management of Western Ranges, Livestock, and Wildlife*, Miscellaneous Publication 281 of the U.S. Department of Agriculture, 1938. Each entry appears but once. Publications relating to more than one subject are under the topic of principal concern in range management. Cross-references are suggested at the beginning of certain sections.

Sources consulted included books, periodicals, publications of the U.S. Government, and of State agricultural experiment stations, releases of regional organizations and private foundations, and abstracted bibliographies. Also included are many items that were listed in the Current Literature sections of the *Journal of Range Management* between May 1962 and September 1968. Periodicals searched were:

Advances in Agronomy
Agronomy Journal
American Forests
American Journal of Botany
American Midland Naturalist
Botanical Gazette
Botanical Review
Contributions of the Boyce Thompson Institute
Ecology
Ecological Monographs
Economic Botany
Forest Farmer
Forests and People
Forest Science
Gulf Coast Cattleman
Journal of Animal Science
Journal of Forestry
Journal of Range Management
Journal of Soil and Water Conservation
Journal of Wildlife Management
Plant Physiology
Proceedings, Louisiana State University Forestry Symposium
Proceedings, Society of American Foresters
Proceedings, Southeastern Association of Game and Fish Commissioners
Proceedings, Southern Weed Conference
Proceedings, Tall Timbers Fire Ecology Conference
Soil Conservation
Soil Science
Soil Science Society of America Proceedings
Southern Lumberman
Transactions, North American Wildlife and Natural Resources Conference

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[1] U.S. Department of Agriculture: respectively, Southern Forest Experiment Station, Forest Service, New Orleans, La.; Southern Region, Forest Service, Atlanta, Ga.; and Soil Conservation Service, Gainesville, Fla.

[2] Campbell, R.S., Halls, L.K., and Morgan, H.P. 1963. Selected bibliography on southern range management. USDA Forest Serv. Res. Pap. SO-2, 62 pp. Southern Forest Exp. Sta., New Orleans, La.

Several members of the American Society of Range Management assisted notably in searching the literature:

W.J. Cloward, Southern Region, USDA Forest Service, Atlanta, Ga.

H.S. Crawford, Southeastern Forest Experiment Station, USDA Forest Service, Blacksburg, Va.

H.E. Grelen, Southern Forest Experiment Station, USDA Forest Service, Alexandria, La.

L.K. Halls, Southern Forest Experiment Station, USDA Forest Service, Nacogdoches, Tex.

J.B. Hilmon, Southeastern Forest Experiment Station, USDA Forest Service, Asheville, N.C.

N.E. Linnartz, School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge, La.

J.E. McCaleb, Florida Agricultural Experiment Station, Ona, Fla.

J.D. Powell, Georgia Agricultural Experiment Station, Americus, Ga.

T.N. Shiflet, USDA Soil Conservation Service, Lincoln, Neb. (formerly at Alexandria, La.)

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Volume Tables and Point-Sampling Factors for SHORTLEAF PINES in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands

Glendon W. Smalley
David R. Bower

SOUTHERN FOREST EXPERIMENT STATION
T. C. Nelson, Director

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Volume Tables and Point-Sampling Factors for Shortleaf Pines in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands

Glendon W. Smalley [1] and David R. Bower [2]

The tables and equations published here provide ways to estimate total and merchantable cubic-foot volumes, both inside and outside bark, of shortleaf pines *(Pinus echinata* Mill.) planted on abandoned fields in the Ridge and Valley, Cumberland Plateau, Eastern Highland Rim, and Western Highland Rim regions of Tennessee, Alabama, and Georgia (fig. 1). There already are about 60,000 acres of shortleaf plantations on such sites, and more are likely to be established. The tables and equations should prove useful in growth and yield studies, forest inventories, timber sales, and management plans.

Basic data were obtained by felling and measuring a total of 305 trees at points throughout the four physiographic regions. Tree ages ranged from 10 to 35 years.

Similar tables are available for loblolly pine *(4)*.[3]

Study Methods

All sample trees were cut off 3 inches above ground on the uphill side. Total height (H) was measured to the nearest foot from ground level on the uphill side to the tip. Forked or other deformed trees were avoided. Additional measurements included diameter outside bark and inside bark at stump height, at breast height (D), and at maximum intervals of 5 feet to tops of 4.0, 3.0, and 2.0 inches o.b. For the tables, the minimum tree considered in each utilization class was 5.0 inches o.b. at breast height. Thus, the tables are based on

[1] Soil Scientist, stationed at the Silviculture Laboratory, maintained at Sewanee, Tennessee, by the Southern Forest Experiment Station in cooperation with the University of the South.

[2] Statistician, Southern Forest Experiment Station, New Orleans, Louisiana.

[3] Italic numbers in parentheses refer to Literature Cited, p. 5.

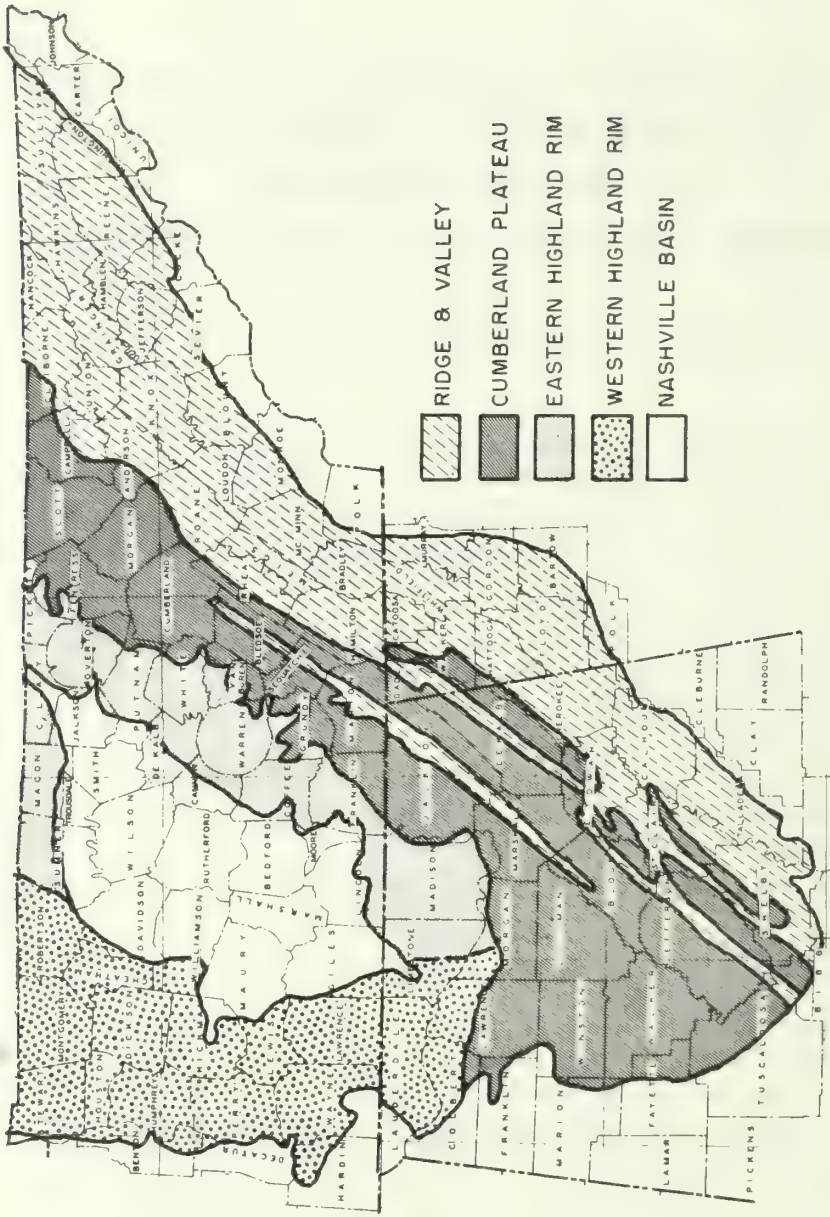

Figure 1.—*Physiographic regions of middle Tennessee, north Alabama, and northwest Georgia.*

data from 168 trees; number of stems measured in each diameter-height category is indicated in table 1. Separate equations were fitted, however, for a larger sample that included 137 stems less than 5.0 inches d.b.h.

Cubic volume of each tree was computed by Smalian's formula. Volumes in the 3-inch stumps were excluded.

Experience with the data on loblolly pine *(4)* indicated that a regression of volume on D^2H would provide an adequate model. For various threshold diameters, three statistical weights were tested: unity, the inverse of D^2H, and the inverse of $(D^2H)^2$. By Furnival's index of fit *(2)*, there was little difference between the inverse of D^2H and the inverse of $(D^2H)^2$. The latter was chosen, as it minimized problems of intersection. The volume tables were therefore derived from weighted linear regressions of the form:

$$V(D^2H)^{-1} = b_1 + b_0(D^2H)^{-1}$$

where

V = gross volume in the appropriate units

D = diameter at breast height, outside bark, in inches

H = total height in feet

b_0, b_1 = regression constants

Fitting the equation by ordinary least squares is the same as weighting the squared residuals of $V = b_0 + b_1D^2H$ by $1/(D^2H)^2$.

A covariance analysis of regressions for total cubic-foot volume outside bark showed no differences, at the 0.01 level of significance, between physiographic regions in either slope or intercept values. The data were therefore combined for computing the values in tables 1, 3, 5, 7, 9, 11, 13, and 15. The equation, the geometric mean of D^2H, and the standard error of estimate are shown below each table.

Tables 2, 4, 6, 8, 10, 12, 14, and 16 give point-sampling factors for each combination of tree diameter and height appearing in the corresponding volume table. Volumes per square foot of basal area were derived by dividing each volume equation by $0.005454D^2$, a formula for basal area.

In all tables, midpoints of the total height classes are multiples of 5 feet, e.g., 30 = 28 through 32 feet. The midpoint of each diameter class is given, e.g., 7 = 6.5 through 7.4 inches. The boxed portion of each volume table indicates the extent of basic data.

Using the Tables and Equations

The volumes and point-sampling factors in the tables should prove applicable throughout the area indicated in figure 1. For developing the equations on which the tables were based, tree diameters were measured to tenths of an inch and heights were measured to the nearest foot. The same limits of accuracy are recommended in application of the tables or equations.

A point-sampling cruise may be made by measuring diameters and heights of trees counted through a prism or relascope and applying the volume-conversion factors from the even-numbered tables. Volume per acre is computed as follows:

1. Multiply the number of counted trees in each diameter-height class by the point-sampling factor for the class.
2. Sum the products of step one.
3. Multiply the total of step two by the basal area factor of the prism or other angle gage used.
4. Divide the product of step three by the number of points sampled in the plantation.

If a sampling error for the overall average volume per acre is desired, individual point estimates of volume per acre must be calculated, i.e., the tally of each point must be kept separate. Instructions can be found in Beers and Miller *(1)* or Hunt, Baker, and Biskamp *(3)*.

When maximum precision and accuracy are desired, volumes should be computed from the equations rather than read from the tables. For a conventional cruise of trees larger than 5.0 inches d.b.h., volumes for any combinations of diameters and heights can be obtained by summation of the appropriate equation. Thus, outside-bark volumes of entire stems would be obtained by summing the equation for table 1 over n sample trees:

$$\Sigma V_c(\text{o.b.}) = 0.0027379\ \Sigma D^2H - 0.0326(n)$$

For a point-sampling cruise the corresponding equation (table 2) would be:

$$\Sigma V_p(\text{o.b.}) = BAF(0.5020(\Sigma H) + 5.9771(\Sigma D^{-2}))$$

Individual heights and reciprocals of squared diameters are accumulated over all trees for each sample point.

If the inventory includes trees smaller than 5.0 inches d.b.h., the following equations may be used for total tree volume:

$$V_c(\text{o.b.}) = 0.03532 + 0.002777120D^2H$$

$$V_c(\text{i.b.}) = 0.00885 + 0.001997667D^2H$$

These two equations are not to be compared with those having a minimum-diameter threshold of 5.0 inches. Including smaller trees modifies the slope, so that these equations may intersect with the 5.0-inch equations within the range of sampled data.

The equations used to develop volumes for different top-utilization levels (and 5.0-inch threshold diameters) do not intersect one another within the range of diameters and heights given in the tables.

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Table 1.—*Outside-bark volume of entire stem* [1]

D.b.h., o.b. (inches)	Total height in feet												Basis: trees
	20	25	30	35	40	45	50	55	60	65	70	75	
	Cubic feet												*No.*
5	1.34	1.68	2.02	2.36	2.71	3.05	3.39	3.73	4.07				32
6		2.43	2.92	3.42	3.91	4.40	4.90	5.39	5.88	6.37			45
7		3.32	3.99	4.66	5.33	6.00	6.68	7.35	8.02	8.69	9.36		36
8			5.22	6.10	6.98	7.85	8.73	9.60	10.48	11.36	12.23		29
9				7.73	8.84	9.95	11.06	12.16	13.27	14.38	15.49		19
10						12.29	13.66	15.03	16.39	17.76	19.13	20.50	3
11							16.53	18.19	19.84	21.50	23.16	24.81	2
12								21.65	23.62	25.59	27.57	29.54	2
Basis: No. of trees	1	3	13	19	29	27	39	26	8	2	1	0	168

[1] Derived from $V = 0.0027379(D^2H) - 0.0326$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002544 cu. ft./D^2H.

Table 2.—*Outside-bark volume of entire stem, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	9.8	12.3	14.8	17.3	19.8	22.4	24.9	27.4	29.9			
6		12.4	14.9	17.4	19.9	22.4	24.9	27.4	30.0	32.5		
7		12.4	14.9	17.4	20.0	22.5	25.0	27.5	30.0	32.5	35.0	
8			15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	
9				17.5	20.0	22.5	25.0	27.5	30.0	32.6	35.1	
10						22.5	25.0	27.5	30.1	32.6	35.1	37.6
11							25.0	27.6	30.1	32.6	35.1	37.6
12								27.6	30.1	32.6	35.1	37.6

[1] Derived from $V/B.A. = 0.5020(H) - 5.9771/D^2$.

Table 3.—*Inside-bark volume of entire stem* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.78	1.06	1.33	1.60	1.87	2.14	2.42	2.69	2.96			
6		1.65	2.05	2.44	2.83	3.22	3.61	4.00	4.40	4.79		
7		2.36	2.89	3.43	3.96	4.49	5.03	5.56	6.09	6.63	7.16	
8			3.87	4.57	5.27	5.96	6.66	7.36	8.05	8.75	9.45	
9				5.87	6.75	7.63	8.51	9.39	10.27	11.16	12.04	
10						9.49	10.58	11.67	12.75	13.84	14.93	16.02
11							12.86	14.18	15.50	16.81	18.13	19.45
12								16.93	18.50	20.07	21.64	23.20

[1] Derived from $V = 0.0021767(D^2H) - 0.3052$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002178 cu. ft./D^2H.

Table 4.—*Inside-bark volume of entire stem, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	5.7	7.7	9.7	11.7	13.7	15.7	17.7	19.7	21.7			
6		8.4	10.4	12.4	14.4	16.4	18.4	20.4	22.4	24.4		
7		8.8	10.8	12.8	14.8	16.8	18.8	20.8	22.8	24.8	26.8	
8			11.1	13.1	15.1	17.1	19.1	21.1	23.1	25.1	27.1	
9				13.3	15.3	17.3	19.3	21.3	23.3	25.2	27.2	
10						17.4	19.4	21.4	23.4	25.4	27.4	29.4
11							19.5	21.5	23.5	25.5	27.5	29.5
12								21.6	23.6	25.6	27.5	29.5

[1] Derived from $V/B.A. = 0.3991(H) - 55.9574/D^2$.

Table 5.—*Outside-bark volume to a 2.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	1.28	1.62	1.96	2.31	2.65	2.99	3.33	3.68	4.02			
6		2.37	2.87	3.36	3.85	4.35	4.84	5.33	5.83	6.32		
7		3.26	3.94	4.61	5.28	5.95	6.62	7.29	7.96	8.63	9.31	
8			5.17	6.05	6.92	7.80	8.68	9.55	10.43	11.31	12.18	
9				7.68	8.79	9.89	11.00	12.11	13.22	14.33	15.44	
10						12.24	13.61	14.98	16.35	17.72	19.09	20.46
11							16.48	18.14	19.80	21.46	23.11	24.77
12								21.61	23.58	25.55	27.52	29.50

[1] Derived from $V = 0.0027396(D^2H) - 0.09130$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002572 cu. ft./D^2H.

Table 6.—*Outside-bark volume to a 2.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	9.4	11.9	14.4	16.9	19.4	21.9	24.4	27.0	29.5			
6		12.1	14.6	17.1	19.6	22.1	24.6	27.2	29.7	32.2		
7		12.2	14.7	17.2	19.8	22.3	24.8	27.3	29.8	32.3	34.8	
8			14.8	17.3	19.8	22.3	24.9	27.4	29.9	32.4	34.9	
9				17.4	19.9	22.4	24.9	27.4	29.9	32.4	35.0	
10						22.4	25.0	27.5	30.0	32.5	35.0	37.5
11							25.0	27.5	30.0	32.5	35.0	37.5
12								27.5	30.0	32.5	35.0	37.6

[1] Derived from $V/B.A. = 0.5023(H) - 16.7395/D^2$.

Table 7.—*Inside-bark volume to a 2.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.74	1.01	1.29	1.56	1.83	2.10	2.37	2.65	2.92			
6		1.61	2.00	2.40	2.79	3.18	3.57	3.96	4.36	4.75		
7		2.32	2.85	3.39	3.92	4.45	4.99	5.52	6.06	6.59	7.12	
8			3.83	4.53	5.23	5.93	6.62	7.32	8.02	8.71	9.41	
9				5.83	6.71	7.59	8.47	9.36	10.24	11.12	12.00	
10						9.45	10.54	11.63	12.72	13.81	14.90	15.99
11							12.83	14.15	15.47	16.78	18.10	19.42
12								16.90	18.47	20.04	21.61	23.18

[1] Derived from $V = 0.0021782(D^2H) - 0.3482$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002186 cu. ft./D^2H.

Table 8.—*Inside-bark volume to a 2.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	5.4	7.4	9.4	11.4	13.4	15.4	17.4	19.4	21.4			
6		8.2	10.2	12.2	14.2	16.2	18.2	20.2	22.2	24.2		
7		8.7	10.7	12.7	14.7	16.7	18.7	20.7	22.7	24.7	26.7	
8			11.0	13.0	15.0	17.0	19.0	21.0	23.0	25.0	27.0	
9				13.2	15.2	17.2	19.2	21.2	23.2	25.2	27.2	
10						17.3	19.3	21.3	23.3	25.3	27.3	29.3
11							19.4	21.4	23.4	25.4	27.4	29.4
12								21.5	23.5	25.5	27.5	29.5

[1] Derived from $V/B.A. = 0.3994(H) - 63.8413/D^2$.

Table 9.—*Outside-bark volume to a 3.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	1.07	1.42	1.76	2.11	2.45	2.80	3.14	3.49	3.83			
6		2.18	2.67	3.17	3.67	4.16	4.66	5.16	5.65	6.15		
7		3.07	3.75	4.42	5.10	5.78	6.45	7.13	7.81	8.48	9.16	
8			4.99	5.87	6.76	7.64	8.52	9.41	10.29	11.17	12.06	
9				7.52	8.63	9.75	10.87	11.99	13.10	14.22	15.34	
10						12.11	13.49	14.87	16.25	17.63	19.01	20.39
11							16.39	18.06	19.73	21.40	23.07	24.74
12								21.55	23.54	25.52	27.51	29.50

[1] Derived from $V = 0.0027599(D^2H) - 0.3085$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002765 cu. ft./D^2H.

Table 10.—*Outside-bark volume to a 3.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	7.9	10.4	12.9	15.4	18.0	20.5	23.0	25.6	28.1			
6		11.1	13.6	16.1	18.7	21.2	23.7	26.3	28.8	31.3		
7		11.5	14.0	16.6	19.1	21.6	24.1	26.7	29.2	31.7	34.3	
8			14.3	16.8	19.4	21.9	24.4	26.9	29.5	32.0	34.5	
9				17.0	19.5	22.1	24.6	27.1	29.7	32.2	34.7	
10						22.2	24.7	27.3	29.8	32.3	34.9	37.4
11							24.8	27.4	29.9	32.4	35.0	37.5
12								27.4	30.0	32.5	35.0	37.6

[1] Derived from $V/B.A. = 0.5060(H) - 56.5624/D^2$.

Table 11.—*Inside-bark volume to a 3.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.59	0.86	1.14	1.41	1.68	1.96	2.23	2.51	2.78			
6		1.47	1.86	2.25	2.65	3.04	3.44	3.83	4.23	4.62		
7		2.18	2.71	3.25	3.79	4.33	4.86	5.40	5.94	6.47	7.01	
8			3.70	4.40	5.10	5.80	6.51	7.21	7.91	8.61	9.31	
9				5.71	6.59	7.48	8.37	9.26	10.14	11.03	11.92	
10						9.35	10.45	11.55	12.64	13.74	14.83	15.93
11							12.75	14.08	15.40	16.73	18.05	19.38
12								16.85	18.43	20.00	21.58	23.16

[1] Derived from $V = 0.0021914(D^2H) - 0.5070$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002279 cu. ft./D^2H.

Table 12.—*Inside-bark volume to a 3.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	4.3	6.3	8.3	10.3	12.4	14.4	16.4	18.4	20.4			
6		7.5	9.5	11.5	13.5	15.5	17.5	19.5	21.5	23.5		
7		8.1	10.2	12.2	14.2	16.2	18.2	20.2	22.2	24.2	26.2	
8			10.6	12.6	14.6	16.6	18.6	20.6	22.7	24.7	26.7	
9				12.9	14.9	16.9	18.9	21.0	23.0	25.0	27.0	
10						17.2	19.2	21.2	23.2	25.2	27.2	29.2
11							19.3	21.3	23.3	25.3	27.4	29.4
12								21.5	23.5	25.5	27.5	29.5

[1] Derived from $V/B.A. = 0.4018(H) - 92.9567/D^2$.

Table 13.—*Outside-bark volume to a 4.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.62	0.96	1.31	1.66	2.00	2.35	2.70	3.05	3.39			
6		1.73	2.23	2.73	3.23	3.73	4.23	4.73	5.23	5.72		
7		2.63	3.31	3.99	4.67	5.35	6.03	6.71	7.39	8.07	8.75	
8			4.56	5.45	6.34	7.22	8.11	9.00	9.89	10.78	11.67	
9				7.10	8.22	9.35	10.47	11.60	12.72	13.85	14.97	
10						11.72	13.11	14.50	15.89	17.28	18.66	20.05
11							16.03	17.71	19.39	21.06	22.74	24.42
12								21.22	23.22	25.22	27.21	29.21

[1] Derived from $V = 0.0027765(D^2H) - 0.7722$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0003220 cu. ft./D^2H.

Table 14.—*Outside-bark volume to a 4.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	4.5	7.1	9.6	12.2	14.7	17.2	19.8	22.3	24.9			
6		8.8	11.3	13.9	16.4	19.0	21.5	24.1	26.6	29.2		
7		9.8	12.4	14.9	17.5	20.0	22.6	25.1	27.7	30.2	32.7	
8			13.1	15.6	18.2	20.7	23.2	25.8	28.3	30.9	33.4	
9				16.1	18.6	21.2	23.7	26.3	28.8	31.3	33.9	
10						21.5	24.0	26.6	29.1	31.7	34.2	36.8
11							24.3	26.8	29.4	31.9	34.5	37.0
12								27.0	29.6	32.1	34.7	37.2

[1] Derived from $V/B.A. = 0.5091(H) - 141.5803/D^2$.

Table 15.—*Inside-bark volume to a 4.0-inch top* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	0.25	0.53	0.80	1.08	1.35	1.63	1.90	2.17	2.45			
6		1.13	1.53	1.92	2.32	2.71	3.11	3.50	3.90	4.29		
7		1.84	2.38	2.92	3.46	4.00	4.54	5.07	5.61	6.15	6.69	
8			3.37	4.07	4.78	5.48	6.18	6.89	7.59	8.29	8.99	
9				5.38	6.27	7.16	8.05	8.94	9.83	10.72	11.61	
10						9.04	10.14	11.24	12.33	13.43	14.53	15.63
11							12.44	13.77	15.10	16.43	17.76	19.09
12								16.55	18.13	19.71	21.30	22.88

[1] Derived from $V = 0.0021966(D^2H) - 0.8459$. Geometric mean of $D^2H = 2{,}055$; standard error of estimate = 0.0002521 cu. ft./D^2H.

Table 16.—*Inside-oark volume to a 4.0-inch top, per square foot of basal area* [1]

D.b.h., o.b. (inches)	Total height in feet											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	1.9	3.9	5.9	7.9	9.9	11.9	13.9	15.9	18.0			
6		5.8	7.8	9.8	11.8	13.8	15.8	17.8	19.9	21.9		
7		6.9	8.9	10.9	12.9	15.0	17.0	19.0	21.0	23.0	25.0	
8			9.7	11.7	13.7	15.7	17.7	19.7	21.7	23.8	25.8	
9				12.2	14.2	16.2	18.2	20.2	22.2	24.3	26.3	
10						16.6	18.6	20.6	22.6	24.6	26.6	28.7
11							18.9	20.9	22.9	24.9	26.9	28.9
12								21.1	23.1	25.1	27.1	29.1

[1] Derived from V/B. A. $= 0.4027(H) - 155.0929/D^2$.

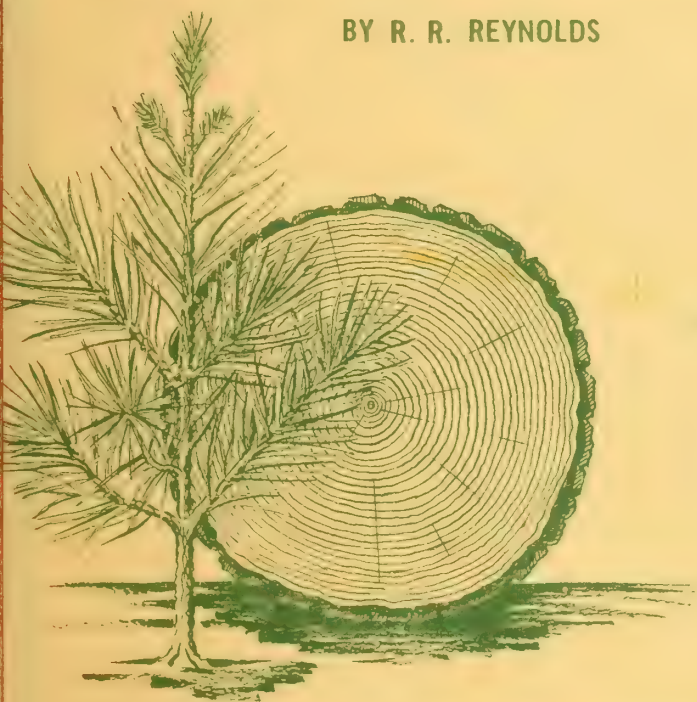
TWENTY-NINE YEARS OF SELECTION

TIMBER MANAGEMENT

ON THE CROSSETT EXPERIMENTAL FOREST

JUN 26 19[illegible]
U.S. FOR. SERV.

BY R. R. REYNOLDS



RESEARCH PAPER
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SOUTHERN FOREST EXPERIMENT STATION
FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

Twenty-Nine Years of Selection TIMBER MANAGEMENT on the Crossett Experimental Forest[1]

R. R. Reynolds

This paper updates an earlier bulletin[2] that reported growth and yield of natural shortleaf-loblolly pine stands managed under the single-tree selection system. It adds 11 years of data to the earlier 18, and thus comprises a 29-year report.

The study was originally intended to answer three questions:

1. Would it be possible to start with previously unmanaged and badly understocked stands, containing an abundance of low-grade hardwoods, and develop them to full pine stocking in a reasonable time?

2. Could the stands be rebuilt at reasonable cost while products to provide current income to the owners were being harvested?

3. Is selection management a desirable permanent system for these and similar stands, and what growth and yields may be expected?

A fourth question might now be proposed: Have results been as promising and satisfactory over the additional 11 years as over the first 18?

The selection system is applied in this study with the objective of growing the maximum volume of high-quality logs for lumber

[1] The former Crossett Lumber Company donated the land and timber for this and other studies and gave encouragement throughout the work; officials of Georgia-Pacific Corporation, present owners of the Crossett Lumber Company properties, have continued the excellent cooperation on this and other research. Acknowledgment is also due W. E. Bond and A. E. Wackerman, who helped plan the study that forms the basis for this publication; I. W. Rawls and D. O. Gammel, who supervised and assisted in much of the cruising, marking, and recordkeeping; A. H. Davidson and W. M. Smith, who did most of the inventorying and marking; Frances Walker, who handled most of the computations and checked all figures in this report; and Jimmie Rawls, who typed the manuscript and revisions.

[2] Reynolds, R. R. Eighteen years of selection timber management on the Crossett Experimental Forest. USDA Tech. Bull. 1206, 68 pp. 1959.

and veneer. Pulpwood is not a primary product, but a large volume of it is derived from tops of sawtimber trees and from thinnings.

The system favors continuous stand improvement. Within the limits of the allowable cut, the poorest and the biologically most mature stems are marked for removal. The immature stems with greatest potential for improvement in size and quality are left to grow. Selection management allows for a gradual buildup of understocked stands, accelerated increment on the best trees, and a gradual increase in the proportion of each acre that is growing large, high-value timber. Danger of severe damage from wildfire or insect attack is always small because logging slash is of low volume and well scattered, and because there never are large areas of young, even-aged trees.

Three cutting cycles are being tested to see if a short cycle, such as 3 years, will result in better growth and returns than a medium cycle of 6 years or a relatively long one of 9 years.

Study Area and Management Methods

The stands are on the Crossett Experimental Forest in extreme south Arkansas. Soils are silt loams of the Memphis-Grenada association. Topography is gently rolling to flat. Site index varies from 85 to 95 feet at age 50 years. Except for a few acres of abandoned fields, the land has always been in forest.

The tract totals 958 acres and is divided into 24 compartments, of which all but two contain 40 acres apiece. Eight compartments are allocated to each of the three cutting cycles (fig. 1).

When the study was begun in 1937, none of the stands had been previously managed. Many contained more upland hardwoods than pine. The pines consisted of grown-up residuals from the virgin forest scattered among second-growth trees that had seeded in after the virgin timber had been cut to a 12-inch d.b.h. limit in 1915. Stocking of pines of all sizes varied considerably from compartment to compartment. On the average, it was about 40 percent (on a cubic- and board-foot basis) of what is presently considered desirable for full production.

Determining the allowable cut.—For the purpose of this study, 100-percent inventories of growing stock have been made at the end of each cutting cycle. By adding the volume cut since the previous inventory to the change in growing stock during the period, an accurate estimate of net growth is had for the period. This 100-percent inventory also provides information for determining the allowable cut on each compartment in each cutting cycle.

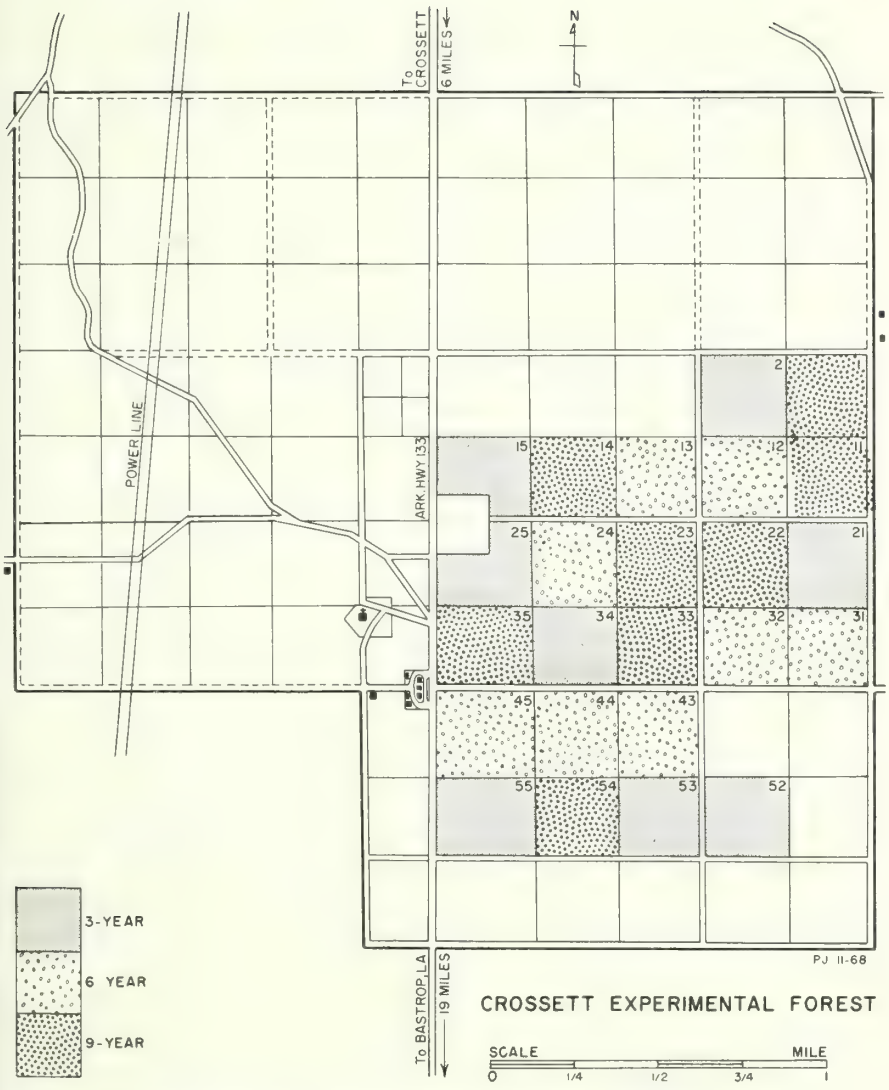

Figure 1.—*Assignment of compartments to cutting cycles.*

Since saw and veneer logs are the objective of management, the volume to be cut at the end of each cycle is determined from the volume in trees 12 inches d.b.h. and larger. A volume closely equivalent to the total board-foot growth is removed if the compartment is fully stocked (approximately 10,000 board feet[3] per acre) at the end of the cutting cycle. In stands not fully stocked, the cut is less than the growth.

Trees that are below log-size (4 to 11 inches d.b.h.) are managed with the thought that only the better ones will eventually be allowed

[3] All board-foot volumes are in International ¼-inch scale.

to grow into log sizes. No allowable cut is determined for these trees; they are thinned on the basis of what is needed to keep them growing well.

Thinning immediately follows the selection harvest of log-size trees. Small groups of younger trees—i. e., those that have seeded into openings made by the removal of older trees—are allowed to remain fairly dense until natural pruning leaves boles clear of live limbs for 30 to 35 feet. Then thinning is heavy in order to allow the selected trees to develop large crowns and grow rapidly.

At the time that management—and the study—was started, up to 50 percent of the cubic-foot volume of the stands was in hardwoods, principally red oak *(Quercus falcata* Michx.), post oak *(Q. stellata* Wangenh.), and sweetgum *(Liquidambar styraciflua* L.). Many of these stems were of low quality, and hence had a very limited market. It also soon became clear that, on these pine sites, even good upland hardwoods could not begin to compete with pine from a financial standpoint. It was accordingly decided to liquidate the hardwood growing stock.

Timber stand improvement.—After the last of the merchantable hardwoods had been removed in the mid-1940's, there still remained many stems, of little or no value, that were competing with pine for light, soil moisture, and nutrients. Accordingly, all hardwoods 4 inches d.b.h. and larger were girdled between 1949 and 1952; and between 1957 and 1961 hardwoods 1 inch d.b.h. and larger were injected with 2,4,5-T. Total cost of carrying out the timber stand improvement program to 1966 has been estimated at $9.27 per acre.

Growth and harvest records.—In planning the study it was thought desirable to schedule about the same amount of harvest cutting each year. Accordingly, two or three 3-year compartments, one or two 6-year compartments, and one 9-year compartment have been cut each year. Some of the compartments of each cycle, therefore, did not receive their first cut until 3, 6, or 8 years (for the 3-, 6-, and 9-year cutting cycles, respectively) after the study was initiated. For this reason growth and harvest records are not available for the same number of years for all eight replications of each cycle. Each of the 3-year compartments has had 10 cuttings, 10 inventories, and nine growth periods. All compartments on the 6-year cycle have had five cuttings and inventories and four growth periods. Three of the 9-year compartments have had four inventories and cuttings and three growth periods, and five compartments have had three inventories and cuttings and two growth periods. The overall time for which growth records are available is, therefore, 27 years for compartments managed on the 3-year cycle, 24 years for the 6-year cycle, and 21.4 years for the 9-year cycle. The average length of the growth period for all cycles combined is 24.1 years.

Loblolly pine reproduction will develop in small openings and under high-crowned trees.

Guiding Diameter Limit

A "guiding diameter limit" is computed prior to marking a compartment for harvest at the end of a cutting cycle. As soon as the cruise of a compartment is completed at the end of the cutting cycle, a stand table is prepared to show the number of trees and log volume, by diameter classes. Total board-foot volume per acre for the compartment is determined. With this figure, and a table of allowable-cut percentages for cutting cycles of various lengths and for various stocking levels, one can compute the amount of volume to be marked for removal.

By referring to the stand table it is possible to accumulate volumes starting with the volume shown for the largest diameter class present on the compartment. Then, the volume for the next largest diameter class is added, and so on until the total is equal to the allowable cut. The diameter class at which this total is reached is the "guiding diameter limit."

Marking all trees in and above this size class would provide the allowable cut. However, some large stems with a very great earning potential are left for additional growth even though they are above the guiding diameter limit. To make up for the volume of these larger "leave" trees, smaller ones of equal total volume, which should come out because of potential lower quality, or because of need for spacing, are marked for removal.

A review of the computed diameter limits for each harvest on each compartment indicates that it has been possible to maintain, and even increase, the supply of large, valuable stems even though stocking was far from desirable when management started and many harvests have been made. The guiding diameter limit for the eight compartments managed on a 3-year cutting cycle averaged 20.4 inches when marking was done for the first cuttings. By the tenth harvest on these compartments the average guiding diameter limit was 22.1 inches.

At the time of the first harvest on the compartments managed on a 6-year cutting cycle the average guiding diameter limit was 19.0 inches; at the time of the fifth harvest the average was 20.4 inches. For the 9-year cycle the figures were 18.6 and 19.3 inches at the first and fourth harvests.

Over all cycles, the guiding diameter limit has increased on 16 of 23 compartments; on three it has remained the same, and on four it has decreased one diameter class. On all compartments there has been an appreciable increase in number of trees 20 inches in diameter and larger.

Volume and Quality of Products Harvested

Volume of timber harvested from the 958-acre tract over the 29-year period 1938-66, inclusive, has been 8,723 M board feet of pine logs, 722 M board feet of hardwood logs, 9,600 cords of pine pulpwood, and 4,700 cords of hardwood pulpwood and acid wood.

Table 1 shows yields by stand development periods. Roughly, the first 9 years were ones in which the forest was being put into shape for increased growth. During this period the mature, the very rough, and the defective pines were removed in improvement cuttings. Oaks capable of yielding saw logs were harvested, a small amount of sweetgum pulpwood was cut, and many oaks 5 to 12 inches in d.b.h. were made into chemical wood or acid wood.

Table 1.—*Volume of forest products harvested*

Period	Pine logs	Hardwood logs	Pine pulpwood	Hardwood pulpwood and acid wood
	Bd. ft.		*Cords*	
1938-46 (9 years)				
Total	1,429,054	531,014	3,559	3,985
Per acre	1,492	554	3.72	4.16
Per acre per year	166	62	.41	.46
1947-55 (9 years)				
Total	2,556,675	190,980	1,457	496
Per acre	2,669	199	1.52	.52
Per acre per year	297	22	.17	.06
1956-66 (11 years)				
Total	4,737,150	.	4,625	201
Per acre	4,945	. . .	4.83	.21
Per acre per year	450	. .	.44	.02
1938-66 (29 years)				
Total	8,722,879	721,994	9,641	4,682
Per acre	9,106	754	10.06	4.89
Per acre per year	314	26	.35	.17

Early in the second 9 years (1947-55) the last of the merchantable hardwood logs were cut, along with the remainder of the acid wood. Pine stocking of log-size trees was increasing rapidly and permitted a harvest of logs that was nearly double the amount taken in the first period. The cut of pine pulpwood was much less than during the first period, because most of the thinning and improve-

ment cutting had been done and the stems that had seeded in or been released during the first period were not yet of pulpwood size.

The harvest of pine logs during the 11-year third period was greater than during the first two periods combined; it averaged 4,945 board feet per acre or 450 board feet per acre per year. The gain signified a large increase in stocking of trees of log size. Pines in the 4- to 11-inch classes also increased greatly during the period, and as a result the cut of pine pulpwood totaled nearly 5 cords per acre.

The average volume per log of the logs cut during the first 18 years was 109 board feet. During the last 11 years the average has been 111 board feet.

Logs averaged 111 board feet (International ¼-inch rule); 35 percent were grade 1.

The grade of logs cut during the first 18 years, as assessed by the Crossett Log Grades [4] was:

Species	Volume	Proportion of total volume in—			
		Grade 1	Grade 2	Grade 3	Total
	M bd. ft.	*Percent*			
Pine	3,956	41	28	31	100
Hardwood	722	20	39	41	100

During the last 11 years the grade of logs was:

Species	Volume	Proportion of total volume in—			
		Grade 1	Grade 2	Grade 3	Total
	M bd. ft.	*Percent*			
Pine	4,737	35	34	31	100

No hardwood logs were made during this period.

Thus, the proportion of grade-3 pine logs was the same during the last 11 years as during the first 18. The proportion of grade-2 pine logs was 6 percentage points higher and that of grade-1 was 6 percentage points lower during the last period than during the first. These changes were expected and do not indicate a continuing trend toward lower quality. Over the first 18 years many of the logs were from residuals of the virgin stand, and these trees had a high percentage of clear length. During the last 11 years more of the cut came from second-growth trees that were younger and had not developed as much knot-free stem as the virgin residuals. The percentage of grade 1 logs should increase as more of the second-growth trees reach larger size.

Changes in Stand Structure

At the time the study began it was realized that pine stocking was considerably below that needed to produce maximum growth of log-size material, and that stocking should be increased, particularly in tree diameter classes of 12 inches and above. Since research

[4] The Crossett Log Grades, in condensed form:

Grade 1.—Surface-clear logs 10.0 inches or larger in diameter inside bark (d.i.b.) at the small end, and logs over 16.0 inches in diameter at the small end containing not more than three 2- to 4-inch knots or the equivalent in small knots.

Grade 2.—Surface-clear logs 8.0 to 9.9 inches d.i.b. at the small end, logs over 8.0 inches containing numerous small knots, or logs over 14.0 inches d.i.b. containing up to six 2- to 4-inch knots.

Grade 3.—Knotty or crooked merchantable logs that are at least 8.0 inches d.i.b. at small end and do not fall into grade 1 or grade 2.

Logs may be from 10 to 21 feet long in all grades.

had not determined the volume or size distribution that would produce this maximum, a tentative goal of 10,000 board feet per acre (at the end of the growth or cutting cycle) was adopted. It was derived from observations of stands that seemed to have the best spacing, growth rate, and stocking. Figure 2 expresses this aimed-for stocking in terms of trees per acre in the various size classes.

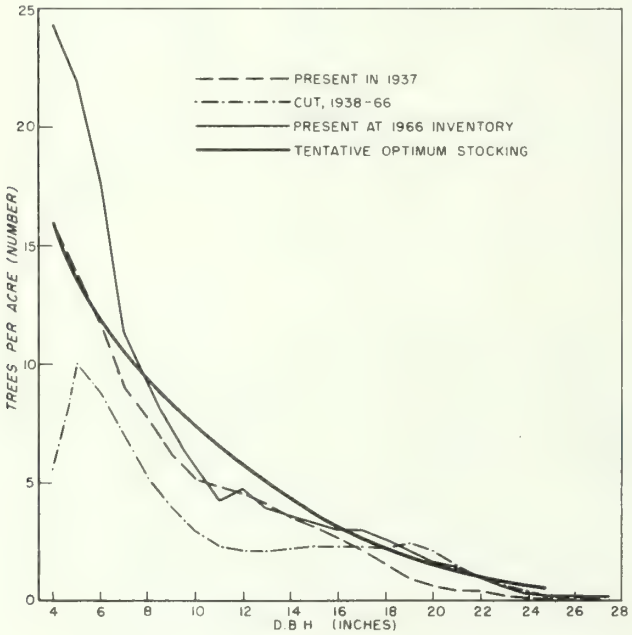

Figure 2.—
Number of pines per acre, and tentative optimum stocking.

At the latest inventories of the compartments the stocking was equal to or greater than the tentative optimum for diameter classes 4 to 9 inches and 16 to 23 inches d.b.h. For other classes it was very close to desirable levels. This was not withstanding that the harvest cuttings had removed about two-thirds of the original number of trees from all diameter classes up to 17 inches d.b.h., and considerably more than the original number of trees for diameter classes above 17 inches.

Since high-quality saw and veneer logs are the prime objective, stocking in the smaller sizes need only be sufficient to furnish recruits for the 12-inch and larger classes and to ensure early pruning of the lower boles of crop trees. As indicated by Figure 2, stocking of the 4- to 7-inch classes, and thus by implication the 2- to 4-inch classes, is considerably above that which seems to be necessary. This situation is no major problem. The surplus will provide many choices of good stems for crop trees, and the extra stems can be eliminated by heavier thinning in the future. Certainly the stand structure indicates that there has been no serious reproduction problem. Even

Pine seedlings and saplings that develop under a high overstory and in small openings prune themselves well and accumulate height but not much diameter. If released in time they produce a maximum of clear length and high-density wood.

if no additional reproduction came in within the next 10 to 15 years there would be sufficient trees in most spots to provide replacements into the log-size classes for 30 years or more and to sustain high volume production for at least 40 years.

Changes in number of pine trees, basal area, cubic volume, and board-foot volume per acre from 1937 to 1966 are shown in Figures 2, 3, 4, and 5. These stand-distribution curves are similar in shape to

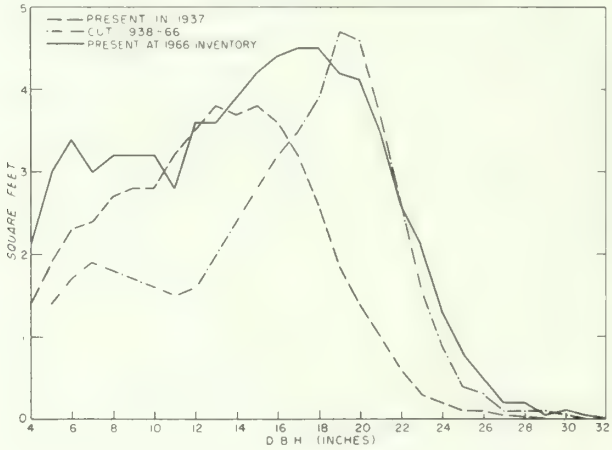

Figure 3.—
Pine basal area per acre, by tree size class.

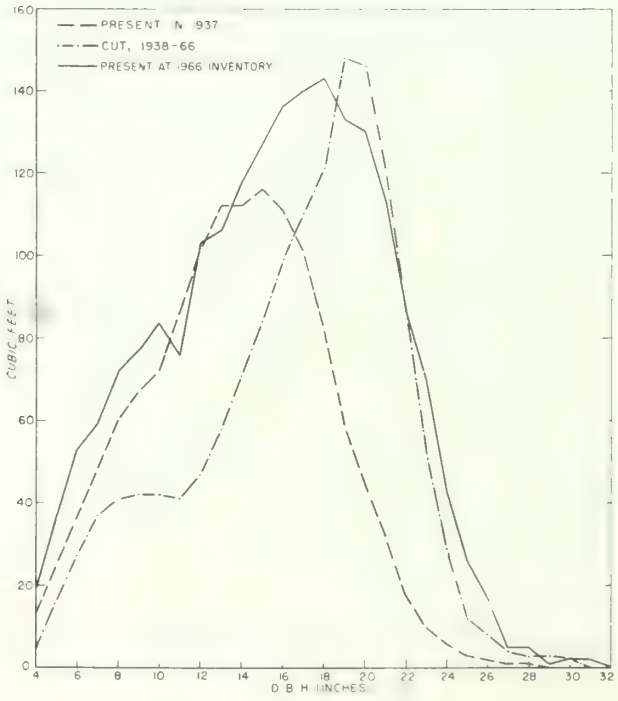

Figure 4.—
Pine cubic volume per acre, by tree size class.

Figure 5.—*Pine board-foot volume per acre, by tree size class.*

those in the 18-year report but are taller and have a broader base. The peak of the board-foot curve was the 17-inch d.b.h. class in 1955. By 1966 the peak had moved over to the 18-inch class. In 1955 the 20-inch class had 616 board feet per acre. In 1966 it had 802. The 24-inch class had 92 board feet per acre in 1955, in 1966 it had 289.

Overall there was a growing-stock increase of 306 cubic feet per acre between 1956 and 1966. Sawtimber growing stock increased 1,229 board feet per acre.

Pine reproduction that came in as a result of stand improvement during the early years of the study is showing up now in the 4- to 10-inch d.b.h. groupings (fig. 2). Eleven years ago, cubic volumes in these classes were considerably lower than in 1937, whereas in 1966 they were considerably higher than in 1937.

Growth

Changes in number of trees per acre are shown in table 2. Exceptionally noteworthy is the increase in the number of trees in the 12-inch d.b.h. and larger classes. The increase in stems 20 inches and larger is even more interesting, because much of the cut has come from this group.

Table 2.—*Change in number of pine trees per acre, by tree size groups*

D.b.h. class (inches)	Cutting cycle					
	3 years		6 years		9 years	
	1937	1966	1937	1966	1937	1966
	Number of trees					
4+	93.8	128.0	95.4	131.4	104.8	140.4
12+	19.9	30.6	25.1	32.0	26.5	33.9
20+	.8	5.3	1.6	6.1	2.1	6.4

Since fewer trees are harvested at one time on the 3-year than on the 6-year cutting cycle, and fewer on the 6- than on the 9-year cycle, it was thought that more trees per acre might develop under

Once the crop trees are given room they develop a large crown and a uniform and rapid growth rate. For many, biological maturity is at 25 inches d.b.h. or more. This tree was 24.9 inches d.b.h. and 51 years of age. Juvenile wood was concentrated in a 10-year-old core that was about 1 inch in diameter.

the shorter cycles. This has not been the case. The increase for the 4-inch d.b.h. and larger groupings was 34, 36, and 36 for the 3-, 6-, and 9-year cutting cycles, respectively.

The average increase in 12- to 18-inch trees was somewhat greater on the short-cycle compartments than on the others, but this was mainly a consequence of unusually heavy ingrowth on three compartments. With this exception, the increase in number of trees per acre was remarkably similar for the three tree-size groups and the three cutting cycles.

Annual growth per acre for the entire study period averaged 82.0 cubic feet on compartments being managed on 9-year cutting cycles, 84.5 for 6-year compartments, and 85.7 for 3-year compartments (table 3). These growth differences were statistically not significant. Variation from one compartment to another, within a cutting cycle, was as great as the differences between cutting cycles.

Table 3.—*Pine cubic-foot growth and cut per acre, in relation to cutting cycle*

Cutting cycle (years)	Growing stock			Total volume harvested, all cuts	Addition to growing stock	Net growth		Average length of growth period
	After first cut	Last inventory	Average volume after cut [1]			Total	Periodic annual	
	Cubic feet							*Years*
3	1,003	1,883	1,314	1,433	880	2,313	85.7	27.0
6	1,109	1,990	1,249	1,146	881	2,027	84.5	24.0
9	1,067	2,061	1,119	760	994	1,754	82.0	21.4

[1] Average of the growing stock reserved on each compartment at the time of each cyclic harvest.

This growth is not large from the standpoint of cords per acre per year, but it is the amount of veneer-log and saw-log growth that is of major consideration; and here performance was excellent. The average was 432 board feet and the maximum difference between cycles was 5 board feet per acre annually (table 4).

Table 4.—*Pine board-foot growth and cut per acre, in relation to cutting cycle*

Cutting cycle (years)	Growing stock			Total volume harvested, all cuts	Addition to growing stock	Net growth		Average length of growth period
	After first cut	Last inventory	Average volume after cut [1]			Total	Periodic annual	
	Board feet							*Years*
3	3,557	8,029	5,325	7,068	4,472	11,540	427	27.0
6	4,302	8,873	5,166	5,801	4,571	10,372	432	24.0
9	4,216	9,330	4,637	4,108	5,114	9,222	431	21.4

[1] Average of the growing stock reserved on each compartment at the time of each cyclic harvest.

Pine growth varied from 386 board feet per acre annually on compartments with an average stocking of 3,513 board feet per acre to 445 board feet where stocking averaged 6,336 board feet (table 5). Periodic annual growth in simple interest averaged 11.0 percent for the lightly stocked areas and 7.0 for the heavily stocked.

Table 5.—*Pine sawtimber growth per acre, in relation to growing stock*

Board-foot volume class and compartment number	Average volume after cut [1]	Cut during growth period	Growing stock at end of growth period	Growth period	Average annual growth	
	– – – – *Bd. ft.* – – – –			*Years*	*Bd. ft.*	*Percent*
Up to 4,000 board feet:						
11	2,990	1,558	7,526	18	363.3	12.2
33	3,764	4,118	9,158	27	383.4	10.2
43	3,784	3,546	8,725	24	411.9	10.9
Average	3,513				386.2	11.0
4,001 to 5,000 board feet:						
53	4,161	5,179	7,439	27	371.4	8.9
45	4,666	5,457	8,515	24	428.6	9.2
15	4,719	5,986	7,264	27	378.3	8.0
14	4,761	2,904	9,214	18	416.0	8.7
44	4,888	5,236	8,014	24	369.5	7.6
13	4,945	5,531	8,966	24	450.8	9.1
35	4,956	3,476	9,984	18	494.6	10.0
23	4,960	6,118	9,703	27	418.8	8.4
Average	4,757				416.0	8.7
5,001 to 6,000 board feet:						
21	5,054	7,606	8,947	27	518.1	10.2
54	5,192	3,878	9,969	18	495.6	9.5
55	5,198	6,471	7,922	27	401.0	7.7
52	5,216	6,993	8,224	27	475.0	9.1
22	5,231	7,348	8,919	27	411.1	7.9
1	5,242	3,462	10,168	18	509.2	9.7
32	5,666	6,873	8,986	24	449.9	7.9
25	5,669	7,434	7,755	27	396.9	7.0
24	5,784	6,764	9,444	24	458.7	7.9
Average	5,361				457.3	8.5
6,001 plus board feet:						
34	6,092	8,006	7,963	27	417.4	6.9
12	6,428	7,201	9,459	24	455.6	7.1
2	6,488	8,869	8,717	27	460.9	7.1
Average	6,336				444.6	7.0
Overall average	5,037				432.0	8.6

[1] Average of the growing stock reserved at the time of each cyclic harvest.

Within volume classes there was substantial compartment-to-compartment variation in growth, though less in the last 11-year period than previously. Much of the variation was caused by differences in the stocking of young trees and in the amount of ingrowth to log sizes. It will be many years before stocking and distribution are uniform on all compartments.

The selection stand on compartment 55 after 10 harvest cuttings at 3-year intervals.

Variations in stocking and ingrowth were still more pronounced in trees of less than log size, and hence stocking of all trees 4 inches d.b.h. and larger had little correlation with periodic annual growth in cubic feet. Over the 24.1-year measurement period for all cutting cycles combined, the average annual growth was 84 cubic feet per acre (table 6); for the first 13.1 years the average was 74. During the last 11 years, growth was 96.1 cubic feet annually, and growth percent was 6.7.

What of the Future?

All indications to date are that the selection system of management is excellent for shortleaf-loblolly pine stands. It seems especially attractive for landowners who wish to grow large, high-grade logs for lumber or veneer. While it requires somewhat more effort than an even-aged system, it provides the marketing advantages that accrue from flexibility and variety in product alternatives, and it avoids the difficulties of regenerating clear-cut areas.

Even though maximum production of large, high-grade logs has been the objective for the study stands, an average of 1.47 cords of pine pulpwood has either been cut or added to growing stock for each thousand board feet of logs harvested or grown. Thus, landowners who are chiefly interested in pulpwood may also be interested in selectively managing some of their stands for large timber. Much cordage would be produced, and the logs would bring high returns either in outright sales or in trades for additional pulpwood.

Table 6.—*Pine cubic growth per acre, in relation to growing stock*

Cubic-foot volume class and compartment number	Average volume after cut [1]	Cut during growth period	Growing stock at end of growth period	Growth period	Average annual growth	
	— — — — *Cu. ft.* — — — —			*Years*	*Cu. ft.*	*Percent*
800 to 1,000 cubic feet:						
11	804	301	1,756	18	73.1	9.1
33	910	788	2,312	27	87.3	9.6
43	1,000	867	2,447	24	111.5	11.2
Average	905				90.6	10.0
1,101 to 1,200 cubic feet:						
44	1,118	969	1,870	24	76.3	6.8
53	1,128	1,285	2,020	27	90.5	8.0
14	1,142	498	1,846	18	67.7	5.9
35	1,177	656	2,155	18	93.6	8.0
22	1,189	1,309	1,975	27	74.9	6.3
Average	1,151				80.6	7.0
1,201 to 1,300 cubic feet:						
45	1,219	1,126	2,067	24	91.6	7.5
1	1,224	624	2,087	18	92.9	7.6
52	1,229	1,459	1,802	27	91.8	7.5
23	1,231	1,198	2,194	27	80.1	6.5
15	1,253	1,264	1,786	27	80.4	6.4
24	1,258	1,230	1,931	24	80.9	6.4
54	1,286	706	2,161	18	88.8	6.9
55	1,287	1,402	2,098	27	95.3	7.4
13	1,297	1,160	1,891	24	82.3	6.3
Average	1,254				87.1	6.9
1,301 to 1,400 cubic feet:						
34	1,331	1,431	1,756	27	76.9	5.8
32	1,369	1,287	1,865	24	74.5	5.4
25	1,386	1,547	1,851	27	84.9	6.1
Average	1,362				78.8	5.8
1,401 to 1,500 cubic feet:						
2	1,440	1,623	1,772	27	78.2	5.4
21	1,461	1,453	1,982	27	87.6	6.0
12	1,484	1,380	1,862	24	74.1	5.0
Average	1,462				80.0	5.5
Overall average	1,227				84.1	6.9

[1] Average of the growing stock reserved at the time of each cyclic harvest.

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